AD/A-012 660

THE DOD LABORATORY UTILIZATION STUDY

John L. Allen, et al

April 1975

KEEP UP TO DATE

Between the time you ordered this report—which is only one of the hundreds of thousands in the NTIS information collection available to you—and the time you are reading this message, several *new* reports relevant to your interests probably have entered the collection.

Subscribe to the **Weekly Government Abstracts** series that will bring you summaries of new reports *as soon as they are received by NTIS* from the originators of the research. The WGA's are an NTIS weekly newsletter service covering the most recent research findings in 25 areas of industrial, technological, and sociological interest—invaluable information for executives and professionals who must keep up to date.

The executive and professional information service provided by NTIS in the **Weekly Government Abstracts** newsletters will give you thorough and comprehensive coverage of government-conducted or sponsored research activities. And you'll get this important information within two weeks of the time it's released by originating agencies.

WGA newsletters are computer produced and electronically photocomposed to slash the time gap between the release of a report and its availability. You can learn about technical innovations immediately—and use them in the most meaningful and productive ways possible for your organization. Please request NTIS-PR-205/PCW for more information.

The weekly newsletter series will keep you current. But *learn what you have missed in the past* by ordering a computer **NTISearch** of all the research reports in your area of interest, dating as far back as 1964, if you wish. Please request NTIS-PR-186/PCN for more information.

WRITE: Managing Editor
5285 Port Royal Road
Springfield, VA 22161

Keep Up To Date With SRIM

SRIM (Selected Research in Microfiche) provides you with regular, automatic distribution of the complete texts of NTIS research reports *only* in the subject areas you select. SRIM covers almost all Government research reports by subject area and/or the originating Federal or local government agency. You may subscribe by any category or subcategory of our WGA **(Weekly Government Abstracts)** or **Government Reports Announcements and Index** categories, or to the reports issued by a particular agency such as the Department of Defense, Federal Energy Administration, or Environmental Protection Agency. Other options that will give you greater selectivity are available on request.

The cost of SRIM service is only 45¢ domestic (60¢ foreign) for each complete microfiched report. Your SRIM service begins as soon as your order is received and processed and you will receive biweekly shipments thereafter. If you wish, your service will be backdated to furnish you microfiche of reports issued earlier.

Because of contractual arrangements with several Special Technology Groups, not all NTIS reports are distributed in the SRIM program. You will receive a notice in your microfiche shipments identifying the exceptionally priced reports not available through SRIM.

A deposit account with NTIS is required before this service can be initiated. If you have specific questions concerning this service, please call (703) 451-1558, or write NTIS, attention SRIM Product Manager.

This information product distributed by

NTIS

U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

FINAL REPORT

THE DOD LABORATORY UTILIZATION STUDY

by

John L. Allen
Rodney E. Grantham
Donald B. Nichols

Office of the Director of Defense Research & Engineering

April 28, 1975

URITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO. AD-A011 900

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
(6) The DoD Laboratory Utilization Study

5. TYPE OF REPORT & PERIOD COVERED
(9) Final rept.,

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
(10) John L./Allen, Rodney E./Grantham Donald B./Nichols

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Office of the Director of Defense Research and Engineering, Washington, D.C. 20301

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
Office of the Director of Defense Research and Engineering, Washington, D.C. 20301

12. REPORT DATE
(11) 28 Apr 75

13. NUMBER OF PAGES
183 (12) 15 p.

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
PRICES SUBJECT TO CHANGE

18. SUPPLEMENTARY NOTES

0 0 0 1 1 3 2 3 0 3

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

*Laboratories
*Department of Defense
Utilization
Management Planning and Control
Contracts
Military Procurement
Manpower Utilization
Personnel Management
Technology
Scientific Research
*Military Research
Army Research
Naval Research
Air Force Research
Military Organizations
*In House Laboratories

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study of the utilization of DoD in-house laboratories was initiated in April 1974 by a memorandum to the Assistant Secretaries of the Military Departments (R&D) in response to a management objective of the Secretary of Defense. The charge for the study was (1) to determine the requirements for DoD laboratories, (2) assess the capability of the laboratories to meet these requirements, (3) identify excess capacity, overlapping capabilities, shortfalls or instances where R&D could be contracted to industry at a savings, and (4) define a program to upgrade the quality of the laboratories.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

266 200 DN

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ACKNOWLEDGEMENT

Early in the course of the Laboratory Utilization Study, the authors asked for "some typing help" from one of the ODDR&E secretaries. Our typist ultimately became our viewgraph maker and expediter, arrangement maker and note taker at briefings. She also volunteered to edit as well as type the final report. So while the thoughts are ours, much of the finished product - some of the words, most of the layout and the style - is a result of the impressive talents and hard work of Mrs. Judy Alexander.

TABLE OF CONTENTS

LABORATORY UTILIZATION STUDY

FIGURES

TABLES

APPENDICES

GLOSSARY OF ABBREVIATIONS

ADTC	Armament Development and Test Center (AF)
AFAL	Air Force Avionics Laboratory
AFAPL	Air Force Aeropropulsion Laboratory
AFATL	Air Force Armaments Technology Laboratory
AFCRL	Air Force Cambridge Research Laboratory
AFFDL	Air Force Flight Dynamics Laboratory
AFOSR	Air Force Office of Scientific Research
AFRPL	Air Force Rocket Propulsion Laboratory
AFSC	Air Force Systems Command
AMARC	Army Materiel Acquisition Review Committee
AMC	Army Materiel Command
AMD	Aerospace Medical Division (AF)
AMMRC	Army Materials and Mechanics Research Center
AMRL	Aerospace Medical Research Laboratory (AF)
APL	Applied Physics Laboratory, Johns Hopkins University
ARL	Aerospace Research Laboratories (AF)
ARO	Army Research Office
ASD	Aeronautical Systems Division (AF)
ASN(R&D)	Assistant Secretary of the Navy (Research & Development)
ATD	Advanced Technology Demonstration

BRL	Ballistic Research Laboratory (A)
BUMED	Bureau of Medicine and Surgery (N)
BUPERS	Bureau of Naval Personnel (N)
CND	Chief of Naval Development
CNM	Chief of Naval Material
CNO	Chief of Naval Operations
CNR	Chief of Naval Research
CNR&T	Chief of Naval Research and Technology
CRP	Contract Research Program
DARPA	Defense Advanced Research Projects Agency
D&F	Determinations and Findings
DCP	Decision Coordinating Paper
DDE	Director of Development and Engineering (N)
DDR&E	Director of Defense Research & Engineering
DLP	Director of Laboratory Programs (N)
DNL	Director of Navy Laboratories
DNT	Director of Naval Technology
DOD	Department of Defense
DS&T	Director of Science and Technology (AF)
DSARC	Defense Systems Acquisition Review Council
ESD	Electronic Systems Division (AF)
FCRC	Federal Contract Research Center
FJSRL	Frank J. Seiler Research Laboratory (AF)

HDL	Harry Diamond Laboratories (A)
HEL	Human Engineering Laboratory (A)
IED	Independent Exploratory Development
ILIR	In-house Laboratory Independent Research
LUS	Laboratory Utilization Study
M&S	Materials and Structures
MERDC	Mobility Equipment R&D Center (A)
MRDEL	Missile Research and Development Engineering Laboratory
MILCON	Military Construction
NADC	Naval Air Development Center
NAVAIR	Naval Air Systems Command
NEVELEX	Naval Electronic Systems Command
NAVFAC	Naval Facilities Engineering Program
NAVMAT	Naval Material Command
NAVORD	Naval Ordnance Systems Command
NAVSEA	Naval Sea Systems Command
NAVSHIP	Naval Ship Systems Command
NAVSUP	Naval Supply Systems Command
NCSL	Naval Coastal Systems Laboratory
NELC	Naval Electronics La oratory Center
NMARC	Naval Material Acquisition Review Committee
NOL	Naval Ordnance Laboratory
NSWC	Naval Surface Weapons Center
NUC	Naval Undersea Center

NUSC	Naval Underwater Systems Center
NWC	Naval Weapons Center
NWL	Naval Weapons Laboratory
OASD(I&L)	Office of the Assistant Secretary of Defense (Installations and Logistics)
OASD(M&RA)	Office of the Assistant Secretary of Defense (Manpower and Reserve Affairs)
ODDRE(R&AT)	Office of Director of Defense Research & Engineering (Research and Advanced Technology)
OMB	Office of Management and Budget
ONR	Office of Naval Research
OSD	Office of the Secretary of Defense
PBD	Program Budget Decision
PM	Program Memorandum
PS&E	Physical Sciences and Engineering
RADC	Rome Air Development Center (AF)
RD&E	Research, Development and Engineering
RDT&E	Research, Development, Test and Evaluation
6.1	Budget category for research
6.2	Budget category for exploratory development
6.3	Budget category for advanced development
6.4	Budget category for engineering development
6.5	Budget category for management and support
RML	Range Measurements Laboratory (AF)

SAMSO	Space & Missile Systems Organization (AF)
TAA	Technical Assessment Annex
Technology Base	RDT&E effort which has been funded by budget categories 6.1, 6.2 and "6.3A"

EXECUTIVE SUMMARY

This is the final report of the Laboratory Utilization Study, initiated in April 1974 by Dr. M. R. Currie, DDR&E, in response to management objectives stated by the Secretary of Defense. The Secretary had indicated concern about the quality and size of the DoD Laboratories. Since about 25 percent of the DoD Research, Development, Test and Evaluation (RDT&E) program is funded through the in-house laboratories of the military services, the efficient management and utilization of these laboratories is recognized to be of crucial importance to the DoD.

A coordinating board, headed by the Deputy Director (Research and Advanced Technology), ODDR&E and consisting of members from the military departments, initiated this study on 20 June 1974. The study focused on four principal issues as follows:

(1) Does the DoD really need in-house laboratories?

(2) If the answer to (1) is in the affirmative, how should the Services' RDT&E structures be organized and managed to get the most out of the laboratories?

(3) What is the most appropriate division of effort between the in-house laboratories, industry, the universities, and other performers in the various areas of the RDT&E program?

(4) What is the proper size of the laboratory complex in view of the foregoing considerations?

Each service carried out its own study which was later integrated into the ODDR&E study. The findings of each Service's study are briefly summarized below.

Army Input - The Army input to this study was the report of the Army Materiel Acquisition Review Committee (AMARC): The AMARC report confirmed the need for Army laboratories but recommended a major reorganization of the current system of 33 laboratories. The new laboratory system would be made up of six mission-oriented development centers (Ground Mobility, Air Mobility, Armament, Communications, Electronics, and Missiles) and four corporate laboratories which do not specifically fit these mission areas. Implementation of this reorganization will result in substantial personnel savings. Other recommendations

included a continuation of the Army's move to "single program element funding" for a strong research and exploratory development program, and several personnel and procurement improvements.

Navy Input - The Navy input to this study expressed the convictions that the Navy laboratories are needed and that the Navy laboratories and test facilities appear to be reasonably matched to the Navy's requirements without unreasonable duplication of facilities and services available elsewhere. Several improvements were stated as being needed in the Navy RDT&E process, notably in the Technology Base (research, exploratory development and early advanced development) effort. This area has a subtask orientation rather than broad program objectives, so that the programs are unduly fragmented. Further, the study concluded that there is poor coupling between the research programs with the remainder of the RDT&E programs. To improve coupling, the study suggested that the planning and management of the research and the exploratory/advanced development programs be under a single command to be entitled the Chief of Naval Research and Technology.

Air Force Input - The Air Force laboratory utilization report, also affirmed their belief in the need for laboratories. The study recommended that the research program be shifted to a predominantly contract operation under a single manager, that Aerospace Research Laboratories be phased out, and that Cambridge Research Laboratories should be funded from the exploratory development category. A command, control, and communication laboratory was recommended to provide an increased level of support in that area. "Single program element funding" is utilized in exploratory development and was recommended to be continued. Many other improvements were suggested in the personnel management and procurement fields.

ODDR&E Study

The ODDR&E follow-on study was conducted by members of the professional staff of ODDR&E(R&AT) whose normal responsibility is the management of the Technology Base programs. This study found, as did the Service studies, that there is a vital role for the laboratories not satisfactorily available from other sources such as industry, universities, FCRC's, Headquarters staffs, Systems Commands, etc. The combination of attributes possessed by the laboratories qualifies them to play a unique and needed role in the military planning function, especially to the planning of systems development acquisition and usage and the planning of the Technology Base program to support future systems development. Laboratories also help the services to be "smart buyers" by providing technical advice and supervision to the

Services interaction with industry, by providing an alternative source of technology so that their existence serves as a source of stimuli to industry to perform well, and by providing centers of excellence in areas of little or no industrial interest.

Before the managements of the Service laboratory systems were examined, a set of management principles was derived, based upon the following tenants: (1) Each laboratory should be assigned the responsibility for an important job, (2) Good RDT&E leadership must be attracted and retained, and (3) There must be sufficient flexibility in the system to allow the leadership to most effectively utilize its talents. These management principles address the question of how to best organize and operate the Services' RDT&E structure and optimize laboratory contributions and reflect the best features of the laboratory systems of the three Services. The Services' proposed management systems were evaluated against these principles.

The ODDR&E study found that the Army laboratories are now, as a result of aggressive improvement programs in recent years, operating in close agreement with the ODDR&E management principles. The AMARC recommendations are in general, endorsed by the study. Additional recommendations are that the Army should: (1) develop and document a system for financial control of the in-house expenditures of R&D laboratories or centers, (2) develop and document a formal planning process (similar to that of the Air Force) for the Technology Base and spell out the program approval authority and (3) develop an R&D career pattern for some officers which includes advanced technical training and laboratory experiences early in their careers to prepare them for senior technical assignments.

The ODDR&E view of the Navy laboratories was that: (1) they are well integrated into many of the Navy programs, including fleet support, (2) they possess a large reservoir of internationally recognized scientists and engineers but (3) their involvement and success in systems development has varied widely from program to program, (4) the Navy Technology Base is fragmented largely as a result of micromanagement by the Systems Commands, (5) there is excess laboratory capacity leading to excess competition and (6) the laboratories technical expertise is not adequately utilized by the System Commands in making critical technical decisions. The ODDR&E study essentially concurs with the description of the problems of the Navy RDT&E structure contained in the report of the Navy's own study. The ODDR&E study concluded that the following problems exist and recommends that the Navy undertake their solutions: (1) redundancy in function/platform assignments and concomitant excessive interlaboratory competition for funds,

(2) Technology Base fragmentation, uneven quality and inhibited technology transfer, (3) lack of a system for control of individual laboratory size and Technology Base in-house/contract ratio and (4) under utilization of junior officer personnel in the laboratories and overdependence on Naval Officers for positions of senior technical responsibility.

The Air Force laboratories were characterized as follows by the ODDR&E study: (1) they generate and execute an innovative, well structured Technology Base program; (2) they utilize military personnel in the laboratories effectively; (3) they specialize in Technology Base programs thereby isolating them from Air Force problems and making their contributions less visible and (4) they pay all salaries out of 6.1 and 6.2 funds, including the salaries for people working in other budget categories, thus causing an unacceptable drain on Technology Base funding. The Air Force study recommendations are generally endorsed and the following additional recommendations are provided: (1) salary support for personnel working on non-exploratory development projects should be supplied from those projects, and (2) controls should be placed on laboratory size consistent with Air Force needs and the anticipated RDT&E budget.

The ODDR&E study provided additional recommendations for improved laboratory management. The concept of a customer-supplier relationship between Program Managers and the laboratories was endorsed as the most appropriate arrangement for work in support of system development. However, it was felt that an effective means was needed to prevent complete subjugation of the laboratories to the Program Managers. To provide a form of "checks and balances" it was recommended that a formal, unedited laboratory comment on the technical risks of any new program be required in the DCP/DSARC process. An appropriately selected laboratory would prepare a Technical Assessment Annex (TAA) for DCP's and Program Memoranda for new programs. The TAA would address any areas of technical risks remaining in the new program and describe plans for addressing these risks. It is believed that this addition to the acquisition process would serve to stimulate involvement between labs and Program Managers. It would also provide a means for monitoring the technical expertise of the laboratories and the quality of their participation in the systems planning and acquisition process. Another conclusion of the service studies endorsed by ODDR&E was that a means be found to operate the laboratories by specifying only their maximum allowable level of in-house funding and leaving decisions on the mix and number of personnel to the laboratory director. Personnel and procurement changes were also recommended.

The in-house to contract funding ratio for laboratory programs was considered carefully in regard to issue (3) by the ODDR&E staff. Funding for DoD research and exploratory development has been essentially flat for the last decade. Meanwhile, inflation has driven the salaries of the personnel performing research and exploratory development activities in the DoD laboratories up by about 40 percent. Since the number of people in the in-house laboratories has decreased only about 10 percent, the in-house costs have escalated, forcing research and development support in industry and the universities to be reduced. This situation has raised serious concern about the balance between in-house activities and the industrial and academic activities. Since each of these contributors bring special strengths to the program, a proper balance must be restored and maintained. Since the imbalances become progressively worse with time, it was concluded that the issue needs addressing now.

The ODDR&E staff examined the in-house-to-contract ratio in research and in each of eight technology areas in exploratory development. It was concluded that there is excessive in-house effort in each of the services: Army, in materials and structures, electronics, conventional weapons and research; Navy, in materials and structures, electronics and conventional weapons; Air Force, in research. If the burden is not to be shifted elsewhere, readjustment of the in-house excesses can only be done by reducing the number of personnel in these technical areas while retaining the associated funds. It is therefore recommended that the Service terminate a sufficient number of low priority efforts to reduce the number of in-house personnel working in the Technology Base (especially in those areas identified above) by a total of approximately three thousand during FY 1976 and an additional 1600 in FY 77. The savings therefrom should be applied to new starts in the contract program.

As part of the Laboratory Utilization Study, examinations were made of the trends in the growth of the in-house laboratory program relative to the size of the DoD budget, and of the content of some of the work in the laboratories. We found that the in-house laboratory share of the DoD budget has increased by about 15% in the past 6 years. No compelling reason for increasing the laboratories' budget was found. To the contrary, there was some evidence of the laboratories being under strain to stay fully employed. Based upon some Service studies and personal visits to most of the laboratories, it is believed that a modest reduction in the size of the in-house laboratories, beyond that required to adjust the in-house/contract ratio in the Technology Base, could produce some savings and eliminate some excessive competition. In order to assess the impacts of various levels of reduction, we examined the laboratory complexes of each of the three Services, and made

cursory impact assessments of levels of reduction. The possibility of reorganizing into single laboratories serving multiple Services in certain areas was also considered. The conclusions were as follows: (1) Implementing the recommendations of the AMARC Study should ultimately produce substantial reductions in personnel in the Army, primarily by the large-scale consolidations of the proposed Armaments Development Center and Harry Diamond Development Center; (2) a drawdown could also be taken in Navy laboratories - either by closing some laboratories and consolidating the work in those remaining, or by selective program elimination or reduction - and would help reduce the inter-laboratory competition to a more appropriate level; (3) the Air Force laboratory system is already quite small and will be decreased by about 10 percent in FY 1975 and 1976.

The examination of the possibility of multi-Service laboratories showed that, if the foregoing reductions were taken first, little additional manpower savings would accrue from multi-Service consolidations. Furthermore, as long as certain weapons are acquired separately by each of the Services, the technical support for this acquisition process makes it highly desirable to keep some supporting technical capability. However, certain streamlining is possible and is being looked at under separate study commissioned by the Joint Logistics Commanders.

As a result of all the foregoing considerations, this study has recommended a decrease of 10 to 15% of the people in the DoD laboratory system (present strength is about 56,000) to take place in FY 76 and 77, to include the Technology Base reduction discussed above.

1. INTRODUCTION

This study of the utilization of DoD in-house laboratories was initiated in April 1974 by a memorandum to the Assistant Secretaries of the Military Departments (R&D) from Dr. M. R. Currie, DDR&E (reproduced in Appendix A) in response to a management objective of the Secretary of Defense. Subsequently, a Coordinating Board, chaired by the Deputy Director (Research & Advanced Technology), ODDR&E and consisting of members from the Military Departments,[1] was formed and initiated the study by a Study Charter issued on 20 June 1974.

1.1 SECDEF Charge

The charge for the study was (1) to determine the requirements for DoD laboratories, (2) assess the capability of the laboratories to meet these requirements, (3) identify excess capacity, overlapping capabilities, shortfalls or instances where R&D could be contracted to industry at a savings, and (4) define a program to upgrade the quality of the laboratories. The study was to be completed and a plan of action to correct any deficiencies identified submitted by 1 January 1975.

1.2 Study Approach

The modus-operandi adopted for the Laboratory Utilization Study (LUS) was:

(1) First, each Service would conduct its own study. In recognition of the well-recognized problem (reference 1)[2] of quantification of R&D performance, it was agreed that they would rely primarily on peer review and user opinions. Involvement of persons from the other Services' laboratory systems was encouraged for cross-fertilization since each Service's laboratories are organized and operated differently from the others.

(2) Maximum use of previous studies (e.g. references 2-16) would be made.

(3) Services' studies would be coordinated by the tri-Service/OSD Coordinating Board.

1/ See Appendix B for membership
2/ See bibliography for references.

(4) Service studies would serve as an input to a follow-up ODDR&E study to assimilate and critique the Service Studies and to carry out any additional investigations needed.

The Army was already involved in an extensive evaluation of their entire materiel acquisition process (AMARC Study, reference 17) which served as the Army input to this study. The Navy and Air Force activated special study teams. Their reports were provided to ODDR&E during September 1974 (references 18 and 19).

The LUS focused on four principal issues in response to the charge:

(1) .Could the DoD function satisfactorily without in-house laboratories?

Assuming the answer to (1) is no:

(2) How can we best organize and operate the Services' RDT&E structure to get the most out of the laboratories?

(3) What is the best division of effort between the in-house laboratories, industry, the universities, and other performers in the various technical areas of the R&D program?

(4) What is the proper size of the laboratory complex in view of the foregoing considerations?

2. FEATURES OF EXISTING SERVICE LABORATORY SYSTEMS

The DoD "in-house" R&D laboratories are a big business (see reference 20) - in FY 73 they had a $2.8 billion cash flow, employed approximately 57,000 civilians and 8,000 military and represented a $2.6 billion investment in facilities and equipments. About 25% of the DoD RDT&E program is funded through the in-house laboratories and about 12% is done in-house. They are obviously a major factor in shaping the nature of the DoD RDT&E program and in determining its quality.

As a first step in evaluating the existing Service laboratory systems, data were collected on the nature of the present system, how it operates and is managed, and how it relates to its parent Service and other sponsors. Existing documents were studied, most of the laboratories were visited separately by both the appropriate Service study teams and by DDR&E representatives and dialogues were carried on with various headquarters personnel. In addition, of course, most of the

people involved had first hand familiarity with the laboratories (see Appendix K for the study memberships).

It was decided at the outset that this study would be limited to the Physical Sciences & Engineering (PS&E) laboratories and their portion of the Service's RDT&E management structure, excluding the personnel and medical type laboratories. This was done to limit the technical range required of the study team. Those laboratories that were included are indicated in Appendix J. The personnel and medical laboratories will be similarly studied in 1975.

2.1 Air Force Laboratory System

The smallest laboratory system is that of the Air Force. Figure 2-1 indicates its salient characteristics. There are 14 Air Force laboratories, two devoted to medical R&D, one to human factors. The remaining 11, the subject of this study, are organized along technical area lines. The total laboratory system has about 10,000 personnel, 70% civilian, 30% military, and an annual budget of slightly over $600M. These laboratories are principally devoted to "Technology Base"[3] activities. About 50% of the laboratories' funds are from the research (6.1) and exploratory development (6.2) budget categories - mostly the latter - and 35% from other RDT&E categories, mostly advanced development (6.3). Only 15% of the laboratories' funding is from non-RDT&E work such as technological support to existing systems and to procurement of new systems. The Air Force, as a matter of policy, depends on industry for most of its Technology Base effort with only 30% of the 6.1 and 6.2 work and 5% of total RDT&E being done in-house.

It should be recognized in comparing the Air Force laboratories with those of the other Services that several other activities participate in the Air Force RDT&E process, contributing manpower comparable to that of the laboratories. The Air Force supports five Federal Contract Research Centers[4] (FCRCs), three of which can be classed as Physical Sciences & Engineering - oriented. These three employ about 5,300 people. In addition, the direct responsibility for

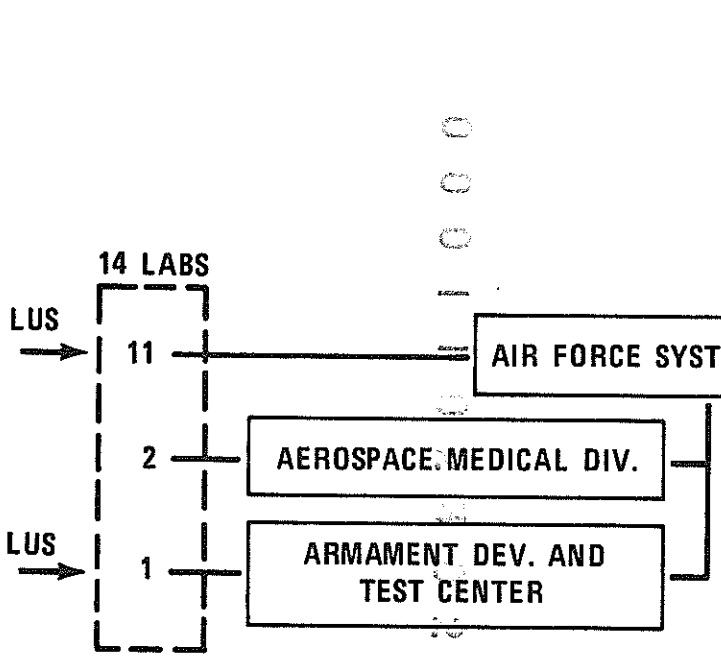
---

3/ Devoted to the development of technology, including new components, devices, subsystems and demonstration models of potential systems (i.e., budget categories 6.1 (research), 6.2 (exploratory development) and the more technology-oriented part of 6.3 (advanced development)).

4/ Aerospace Corp., Mitre Corp., MIT Lincoln Laboratory, Rand Corp. and Analytical Services, Inc. The first three are PS&E-oriented.

FIGURE 2–1

AIR FORCE LABORATORIES COMMAND CHAIN



	TOTAL	LUS LABS
TOTAL PERSONNEL	≈ 10000	≈ 9000
BUDGET ($)	≈ 630M	≈ 600M
FACILITIES & EQUIP ($)	≈ 550M	≈ 520M

SOURCE OF LAB FUNDS

≈ 50%	6.1 + 6.2
≈ 35%	OTHER RDT&E
≈ 15%	NON-RDT&E

LAB I.H. DISPOSITION FUNDS

≈ 30%	OF 6.1 + 6.2
≈ 6%	OF TOTAL SERVICE RDT&E

system development rests with the "Product Divisions" (Electronic Systems Division (ESD), Aeronautical Systems Division (ASD), and the Space and Missile Systems Organization (SAMSO)) which in toto exceed the laboratories in size. Finally, the Air Force Logistics Command also has an engineering staff of over one thousand.

The funding, program planning and approval system of the Air Force laboratories is the simplest of the three Services, in part a result of the Air Force laboratories concentration on the Technology Base. It is indicated schematically in Figure 2-2. The laboratories are "single program element funded" for their exploratory development work and block funded for any research activities (i. e., they receive the bulk of their 6. 1 and 6. 2 funding in a lump sum). The detailed planning of the Technology Base program is done by the laboratories in response to policy guidance from the Director of Science & Technology (DS&T) in a formal system (reference 21) which provides for advisory inputs from potential customers and other laboratories. The Technology Base program approval authority in the Air Force resides in the first echelon over the laboratories in the office of the DS&T in the Air Force Systems Command headquarters.

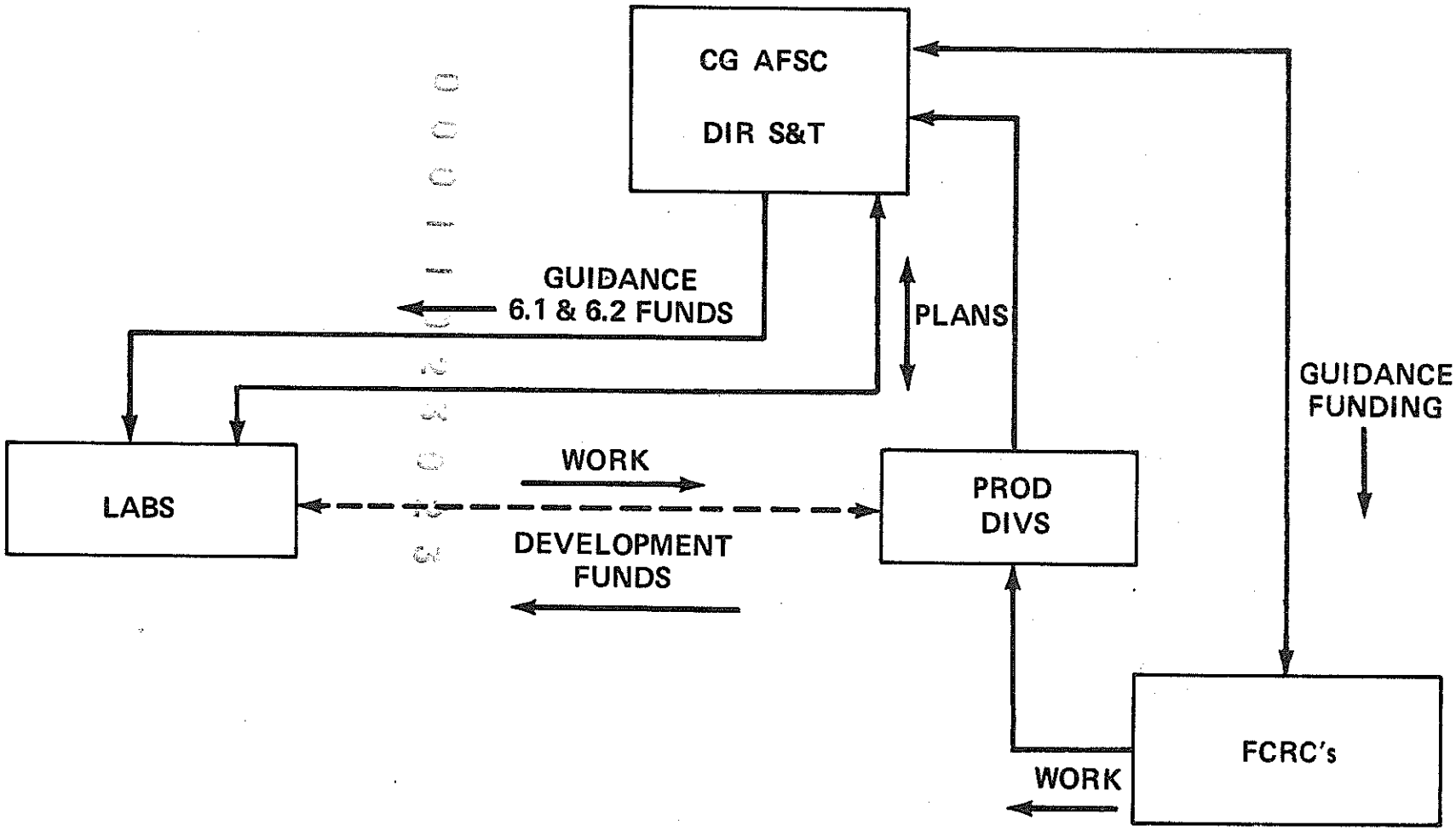
The laboratory's direct support to the system development process (the latter stages of category 6. 3 and category 6. 4 engineering development) is estimated at about 25%. It is provided mostly at little or no cost to the Product Division customers, with the salaries of those so engaged paid from the block funded (6. 1 and 6. 2) program elements.

The Air Force has an R&D officer career pattern unique among the Services which usually features post graduate education, an early tour in a Laboratory as a "bench-level" engineer or scientist and usually includes duty in program management as well as more responsible laboratory positions. The career pattern appears successful in that a survey (Appendix H) indicated about 20% of Air Force officers who became laboratory commanders (as colonels) in the past ten years were promoted later to general officer.

Most, but not all top positions in the Air Force laboratories are held by Air Force officers. There are enough civilians in top jobs to lend some credence to the Air Force claim of selecting the "best man for the job." The intermingling of military and civilians is evident at all levels and appears to work more smoothly than in the other Services.

FIGURE 2–2

AIR FORCE LAB INTERACTIONS



2.2 Navy Laboratory System

The salient characteristics of the Navy laboratory system are indicated in Figure 2-3. This is the largest laboratory system of the three Services, employing approximately 32,000 personnel, 93% of them civilian. It had an annual budget of approximately $1.2B in FY 73. There are 27 designated Navy laboratories but many of these are small medical laboratories. About 90% of the manpower is in the eight laboratories reporting to the Chief of Naval Material (CNM) and the one laboratory (NRL) reporting to the Chief of Naval Research (CNR). This study principally concentrated on these nine laboratories. They are large RDT&E centers, most of which are engaged in a full spectrum of technological activities covering all categories of R&D, engineering support to fielded systems and occasional direct participation with operational forces. As indicated on the figure, about 20% of the laboratory funding is from 6.1 and 6.2, 40% other RDT&E categories and 40% from non-RDT&E funding, such as O&M and procurement funds. About 50% of 6.1 and 6.2 and 20% of total Navy RDT&E is done in-house. In addition to approximately 30,000 people in these PS&E laboratories, the Navy has three FCRCs,[5] two of which are PS&E-oriented with a staff of 2440.

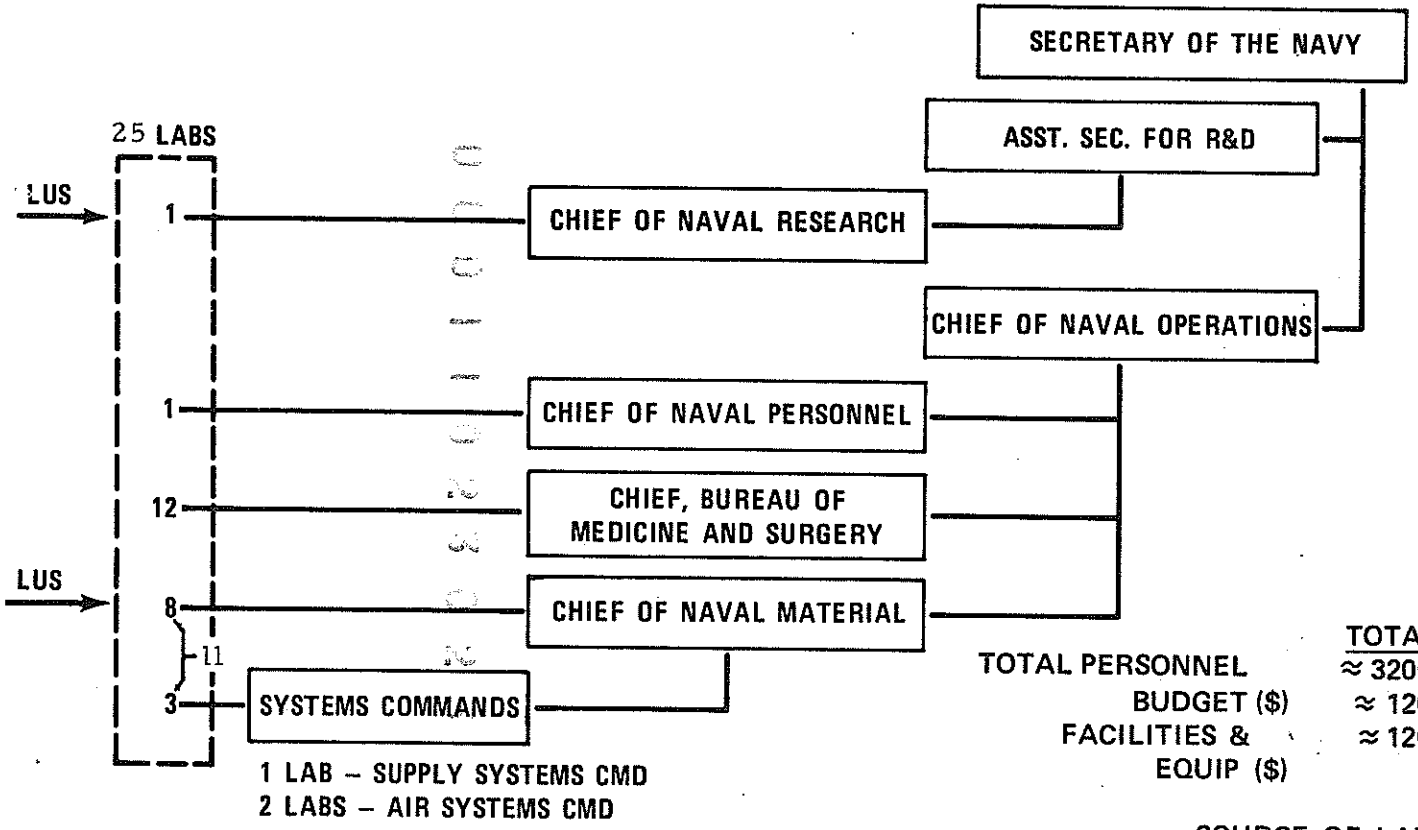
The Navy laboratory operation is largely a "free enterprise system" in which the laboratories sell their services on an industrially funded basis to potential customers, most of whom are offices of the Navy System Commands. Although there are limiting mission statements for each of the laboratories, the laboratories are encouraged to compete with one another with little regulation. The result is a system which exhibits an aggressive vitality in soliciting work. However, several years of such competition has led to a diffusion of capabilities and a plethora of alternate sources for almost any technology. Figure 2-4 indicates the degree of this multiple involvement as indicated by a recent Navy study of laboratory "product lines" (reference 22).

The Navy funding, program planning and approval system is the most complex of the three Services. The ODDR&E perception of it is indicated in Figure 2-5. Separate organizations have cognizance over research, over exploratory development and over other RDT&E work. The cognizant organizations for each category put most of their

5/ John's Hopkins University Applied Physics Laboratory, Penn State University Applied Research Laboratory and the Center for Naval Analyses; the first two are PS&E oriented.

FIGURE 2–3

NAVY LABORATORIES COMMAND CHAIN



	TOTAL	LUS LABS
TOTAL PERSONNEL	≈ 32000	≈ 30000
BUDGET ($)	≈ 1200M	≈ 1100M
FACILITIES & EQUIP ($)	≈ 1200M	≈ 1150M

SOURCE OF LABS FUNDS

≈20% 6.1 + 6.2

≈40% OTHER RDT&E

≈40% NON-RDT&E

LAB I.H. DISPOSITION OF FUNDS

≈50% OF 6.1 + 6.2

≈20% OF TOTAL SERVICE RDT&E

FIGURE 2-4
PRODUCT AREA OVERLAP
IN NAVY LABORATORIES*

Limited to product areas funded ≥ $25M, labs with ≥ 10% of product funding.

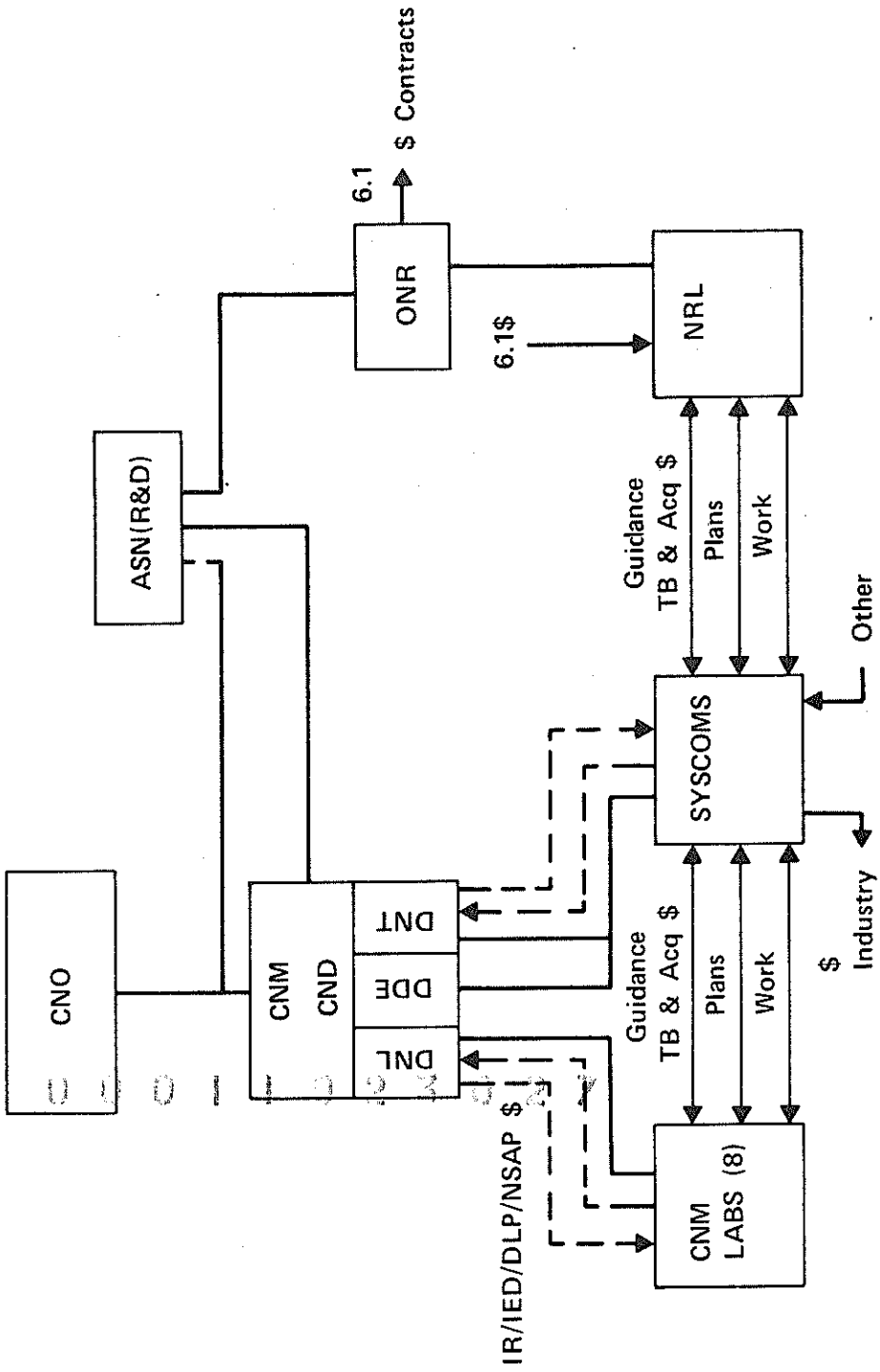
Product Area \ LAB	NADC	NWC	NSRDC	NOL	NWL	NCSL	NELC	NUC	NUSC	ARL	APL	NRL
ACOUSTIC SENSORS	XXXX							XXXX	XXXX			XXXX
COMMAND CONTROL	XXXX						XXXX		XXXX			
COMMUNICATIONS	XXXX						XXXX		XXXX			XXXX
CM & DECOYS					XXXX	XXXX		XXXX	XXXX			
ELECTRONIC WARFARE		XXXX			XXXX							XXXX
ELECTRO-OPTICS	XXXX			XXXX								XXXX
FIRE CONTROL		XXXX			XXXX				XXXX		XXXX	
GUNS & AMMO		XXXX		XXXX	XXXX							
MINES				XXXX								
MISSILES		XXXX									** (XXXX)	
TORPEDOES				XXXX				XXXX	XXXX	XXXX		
EM SURVEILLANCE							XXXX					XXXX
SEA VEHICLES			XXXX									

*Abstracted from the Hollingsworth Report (ref. 19)

**APL had less than 10% of the Navy missile funding in the year in question, but is normally more heavily involved therein.

FIGURE 2-5

NAVY LAB INTERACTIONS



money into the System Commands who in turn distribute the funding to the Navy laboratories and other participants.

In the case of system development work, the system is fairly straight forward with the program managers for the major programs (located either in the System Commands or in Naval Material Command Headquarters) running the programs and using the laboratories in a manner deemed most fitting to their particular purposes and perceptions. Lab involvement in this type of work varies widely from deep and extensive to non-existent, reflecting the program manager's convictions and past experience.

In the case of the Technology Base work, the system is more complicated. Research funding originates from CNR and is passed to contractors, NRL, the Systems Commands and to the Director of Navy Laboratories (DNL) for his In-House Laboratory Independent Research (ILIR) fund. Exploratory development is managed by the Chief of Naval Development (CND) who assigns most of the funds to the System Commands and a small amount to the DNL for the Laboratory Independent Exploratory Development (IED) fund. DNL is charged with the administrative responsibility for the laboratories and dispenses and administers the ILIR & IED funds. The bulk of the Technology Base funding is in 19 exploratory development program elements officially administered by the CND staff but in actual fact parceled among the System Commands in the manner indicated in Table 2-1. This funding is in turn parceled out among the various offices within the System Commands and then to the laboratories and contractors in work units that average $100K each.

The responsibility for structuring a cohesive Technology Base program responsive to Navy needs and for implementing this program in the laboratories is thus spread among several organizations.

Virtually all of the lab staffs and the majority of the CND and System Command staffs are civilian. The use of junior officers as practicing technologists in the labs is uncommon, so few senior officers have any appreciable "bench experience." It is Navy policy, however, to place a Naval Officer in charge of each laboratory - with a civilian Technical Director - and to fill most of the key System Command positions similarly. The Navy RDT&E system is thus almost totally civilian at the lower and intermediate levels and totally military - with civilian technical advisers - at the top.

TABLE 2-1

DISTRIBUTION OF 6.2 PROGRAM ELEMENT FY'75
($ In Thousands)

	PROGRAM ELEMENT	ONR	AIR	ELEX	FAC	SEA	SUP	BUMED	BUPERS	NAVMAT DLF	NAVMAT IED/AP	Total
1.	Aircraft	550	19,916									20,466
2.	Msle Propulsion Tech		4,387			2,679						7,066
3.	Strike Wrfr Weap Tech	1,119	15,304			13,433				4,414	2,480	36,750
4.	Nuclear Propulsion					24,412						24,412
5.	Ships, Subs & Boats	165				15,737				2,100	2,285	20,287
6.	Undersea Wrfr Weap Tech	117	128			15,554				2,300		18,099
7.	Undersea Target Surveill	2,734	7,413	3,116		7,223				2,970		23,456
8.	Surf/Aerospace Tgt Surveill	2,631	4,692	3,931		1,995				1,016		14,265
9.	Command & Control Tech	2,308	4,605	7,318		1,921						16,152
10.	Countermeasures Tech	1,141	4,343	2,436		4,095				921		12,936
11.	Biomedical Tech	50	644				450	6,338				7,482
12.	Ocean & Atmosp Spt Tech	3,324	2,489	2,725	1,278	4,492				3,161		17,469
13.	Logistics Tech		2,116	390	2,706	2,459	2,760					10,431
14.	Materials Tech	105	2,965	310	318	9,048				660		13,406
15.	Electronic Device Tech	1,080	1,910	6,247		1,075				2,740		13,052
16.	Human Resources	948	3,424	810		680			2,086	1,500		9,448
17.	Chem/Bio Defense Tech									150		150
18.	Energy & Envir Prot Tech	1,142	463		2,957	1,396	419	410				6,787
19.	Lab Indp. Explo Dev										13,094	13,094
	Totals	17,414	74,799	27,283	7,259	106,199	6,748	6,748	2,086	21,932	17,859	285,208

2.3 Army Laboratory System

The Army laboratory system is intermediate in number of personnel with approximately 23,000 personnel, 90% of which are civilian, located in 33 laboratories as indicated in Figure 2-6. The LUS concentrated on laboratories reporting to the Army Materiel Command (AMC) excepting the Human Engineering Laboratory which will be included in the later study. The laboratories are typically small but many of them are organizationally and geographically amalgamated by Commodity Command into larger functional units. They are involved in a spectrum of activities, having more full spectrum capability than the Air Force laboratories but concentrating more on RDT&E work than the Navy laboratories. Thirty percent of the laboratory funds are from categories 6.1 and 6.2 and 45% from other RDT&E categories. The Army laboratories have the highest in-house ratio of the three Services with about 62% of the 6.1 and 6.2 being done in the laboratories and 23% of the total Service RDT&E. The Army no longer has any FCRCs or any other appreciable engineering capability outside the laboratories.

The program initiation, approval and funding system incorporates features from both the Navy and Air Force systems and is indicated schematically in Figure 2-7. Work in support of systems planning and development is industrially funded by the program managers. Competition is controlled by the alignment of laboratories with Commodity Commands, but stimulated by the alternate sources of technological support represented by the corporate laboratories (HDL, BRL, AMMRC and HEL). The Technology Base is block funded to the laboratories with each laboratory receiving funds from one or at most a few program elements. Lead laboratories are designated for major technology areas and all funds for that area are assigned by the lead laboratories. Program planning and program execution responsibility resides in the lead laboratory. The program planning for the Technology Base is initiated at the level of the RDT&E director for each Commodity Command. The involvement of the laboratories differs between Commodity Commands with some Commands using the laboratories extensively in the Technology Base planning process and some using them little. The appropriate Commodity Command and then Headquarters AMC approve the resulting plans, except in the case of the Corporate Laboratories which report directly to AMC.

The military civilian interface is similar to that of the Navy in that i.e., very few officers acquire a working-level laboratory experience in their careers, so many of the senior officers in the laboratories must function without this background. However, at the top levels, there is a mixture of military and civilians with about half the top RDT&E positions filled from each group.

FIGURE 2–6

ARMY LABORATORIES COMMAND CHAIN

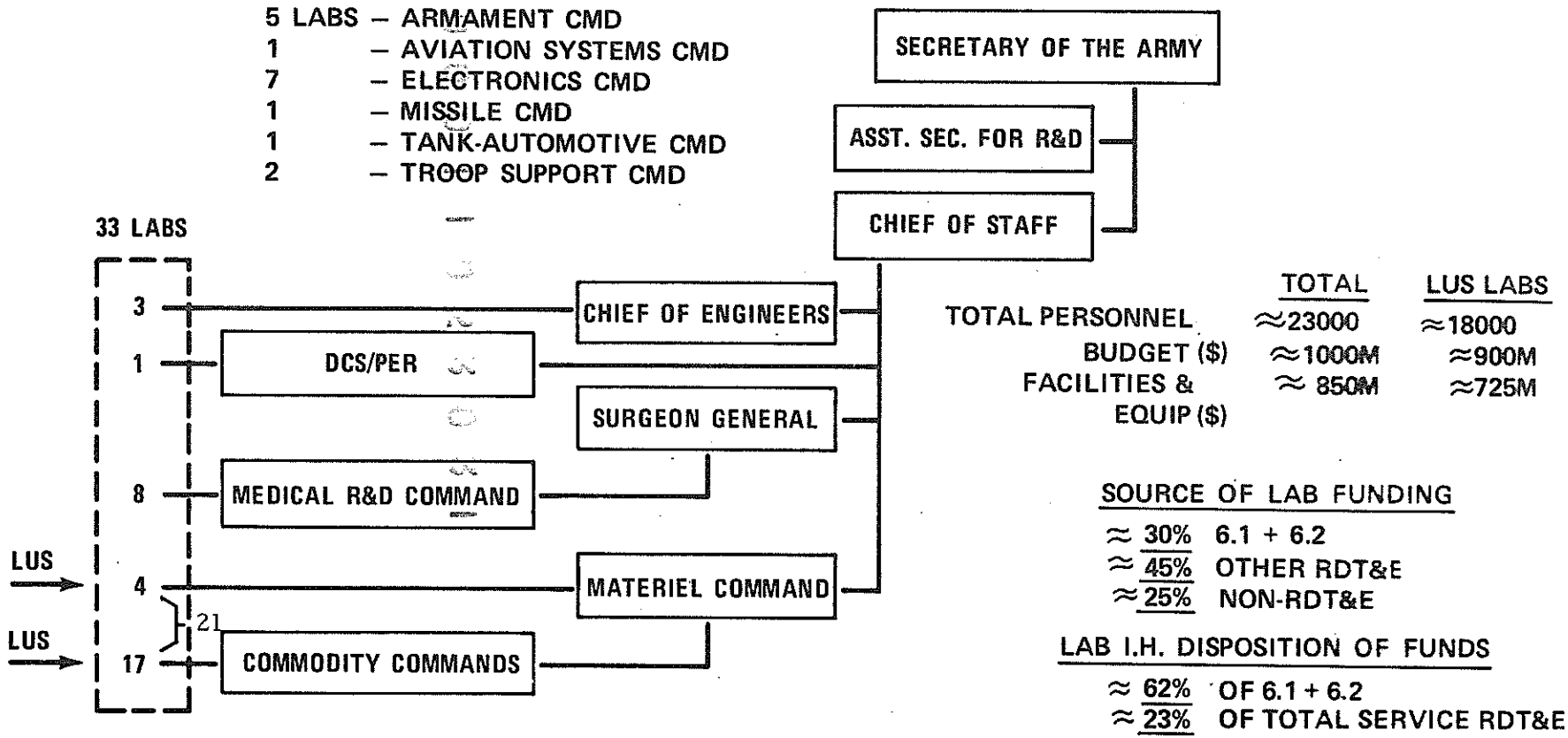
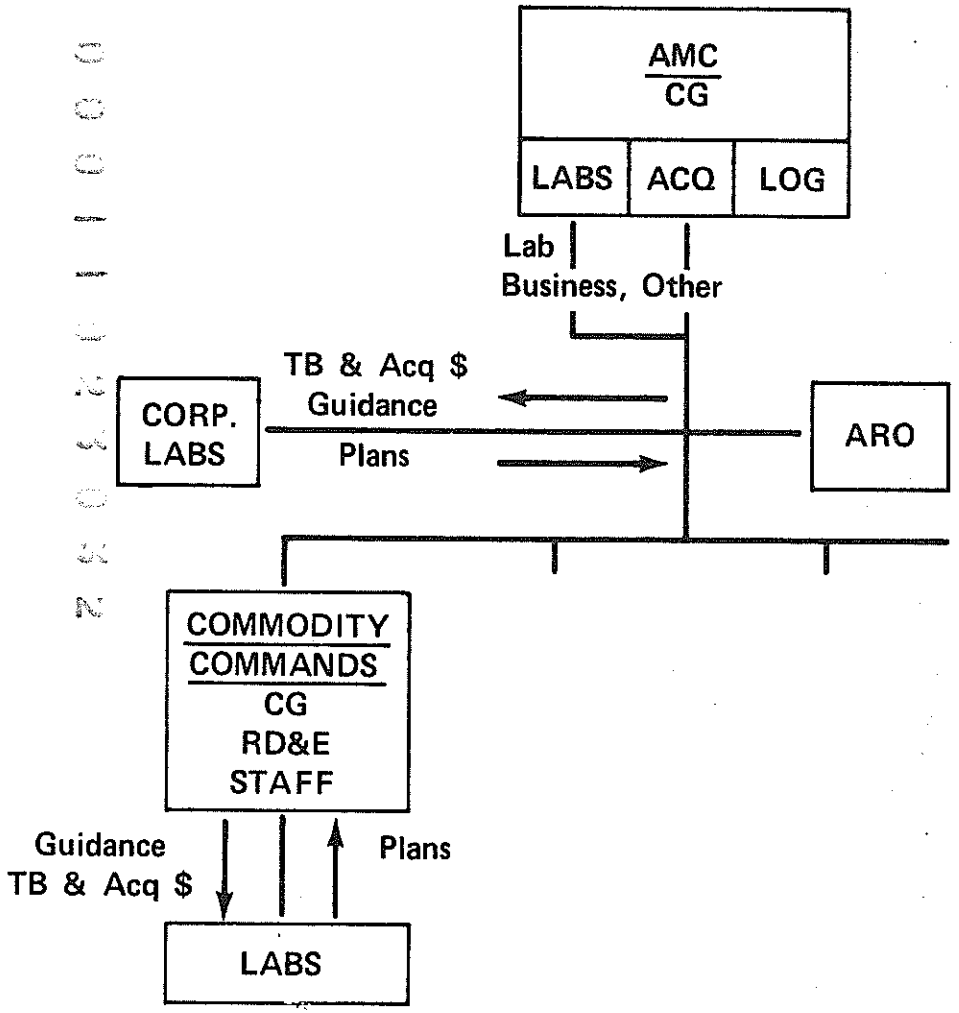


FIGURE 2–7

ARMY LAB INTERACTIONS



3. OVERVIEW OF SERVICE STUDIES

In order to keep the summary of the Service studies reasonably short, extensive use is made of the usual abbreviations for laboratories and other RDT&E organizations in this section. The bewildered reader will find the glossary of abbreviations (pages iv-viii) helpful.

3.1 Army Study

The Army input to the LUS was the AMARC Study (reference 17), which provided a comprehensive review of the entire materiel acquisition process. The AMARC membership is given in Appendix K.

The major recommendation of AMARC relevant to laboratories was that the current laboratory system be reorganized into six (6) mission oriented Development Centers (Ground Mobility, Air Mobility, Armament, Communications, Electronics and Missiles) and the remaining organizations (Natick, MERDC, AMMRC, HEL) which do not specifically fit these mission areas be designated as corporate laboratories (see Figure 3-1). Implementation of these recommendations implies substantial personnel reductions as the Development Centers are established and duplicative support functions are reduced or eliminated. Additionally, an organizational change was proposed (see Figure 3-2) to reduce management layering by separating the development and logistics functions within the Commodity Command so that the Development Center would report directly to headquarters AMC.

Additional recommendations by the Science and Technology Team were:

(1) Assign combat officers with appropriate experience to act as consultants on user aspects of the program at development centers. Also, scientific and engineering personnel should have the benefit of more contacts with operational exercises and tests.

(2) Make better use of other government laboratories. Management checkpoints should be established to assure that consultation and coordination with other Army, Defense or Federal laboratories is not overlooked in planning R&D tasks. It is expected that the additional "job security" afforded by mission responsibility ("lead lab") assignments made in recent years will make the laboratories less reluctant to interact with other laboratories.

FIGURE 3–1

CONSOLIDATION OF AMC LABORATORIES AND RD&E ACTIVITIES INTO DEVELOPMENT CENTERS

DEVELOPMENT CENTERS	GROUND MOBILITY	AIR MOBILITY	ARMAMENT
ILLUSTRATIVE MAJOR MATERIEL MISSIONS	Ground Vehicles Tanks Materials Handling Equipment Earth-Moving Equip Propulsion & Suspension Tech	Air Mobility Tech Rotary Wing Tech Army Air Operations Air/Ground Avionics Drones	Weapons & Wpn Sys Nucl & Conv Ammo Fire Control Equip Mines, Grenades Pyrotech, Smoke Chemical Materiel Def Bio & Rad Mats

RD&E ACTIVITY CONSOLIDATIONS:

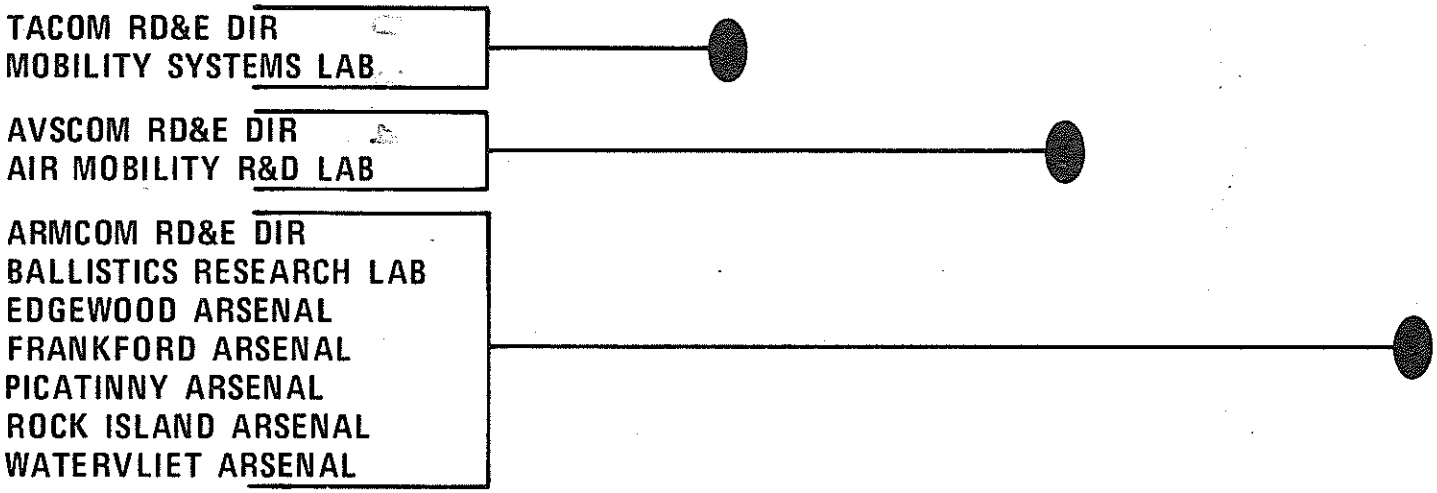


FIGURE 3–1
CONTD

CONSOLIDATION OF AMC LABORATORIES AND RD&E ACTIVITIES INTO DEVELOPMENT CENTERS

DEVELOPMENT CENTERS	COMMUNICATIONS	ELECTRONICS	MISSILE
ILLUSTRATIVE MAJOR MATERIEL MISSIONS	Tactical Communications Strategic Communications Satellite Communications ADP Equipment IFF Systems	Surveillance/Sensor Night Vision Electronic Fuzes Electronic Warfare Atmospheric Sciences	Free Rockets Guided Missiles Ballistic Missiles Air Defense Msls Missile Fire Control Guidance Technology

RD&E ACTIVITY CONSOLIDATIONS:

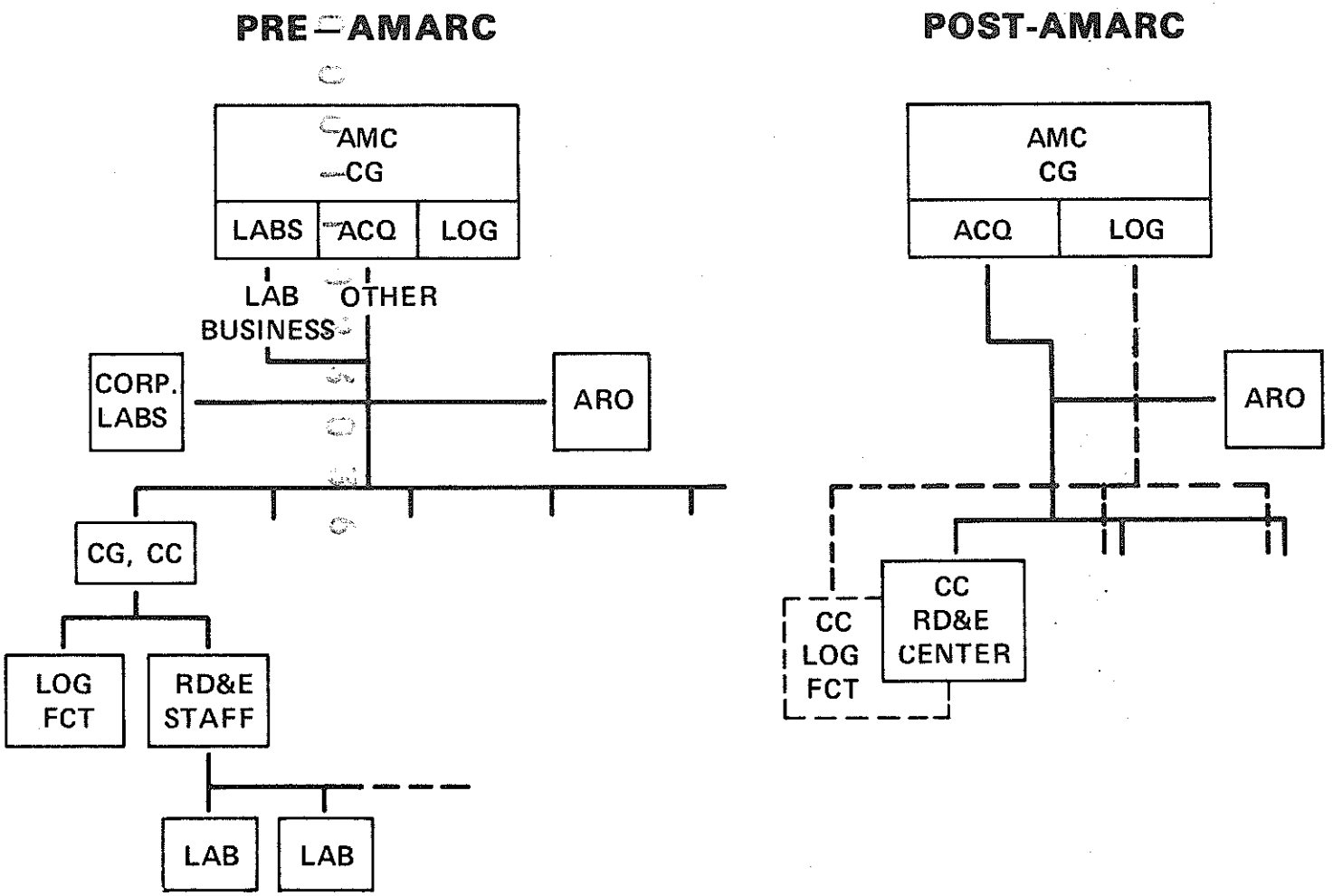
- ECOM RD&E DIR
  COMMUNICATIONS ADP LAB
  ELEC TECH & DEVICES LAB
  AVIONICS LAB
  ELEC R&D TECH SPT ACT
  SATCOM RD&E ELEMENTS
- HARRY DIAMOND LAB
  COMBAT SURVEILLANCE
  NIGHT VISION LAB
  ELECTRONIC WARFARE
  ATMOSPHERIC SCIENCES
- MISSILE RD&E LAB

NATICK LAB
MERDC
MATERIALS & MECHANICS
HUMAN ENGINEERING

NOTE: No changes anticipated; established as Corporate Laboratories

FIGURE 3–2

AMC LAB/CENTER ORGANIZATIONAL CHANGES PROPOSED



(3) Continue to appraise the "worth" of the new Army development centers systematically and regularly in AMC headquarters.

(4) Maintain a climate in the laboratories favorable to innovation useful to the Army. The team recommended especially that middle management should be advised that the absence of a specific Army requirement does not, in itself, suffice to justify the termination of a research or exploratory development effort; however, the absence of any conceivable Army application should continue to require the termination of a research or development effort.

(5) Try harder to overcome the Civil Service constraints.

(a) The Secretary of Defense was urged to work in a vigorous and a positive way with the Congress and with the Civil Service Commission to seek needed reform in Civil Service. In addition, the Secretary of the Army should continue action to insure that internal Army practices do not make the situation even more restrictive than Civil Service regulations allow.

(b) Special teams consisting of selected personnel experts and successful R&D directors and managers were suggested to visit Army installations to train and advise R&D managers on successful ways of dealing with Civil Service manpower problems. It was suggested that such teams could also advise OSD on specific Civil Service problems and reforms which would serve as the basis of DoD proposals to the Congress or the Civil Service Commission for change.

(6) Consider possibilities of contractor operations at development centers, if Civil Service restrictions and internal Army problems continue to interfere with the attainment of high performance.

(7) Maintain a strong Technology Base. It was felt that Army decision makers need to be more aware of the need for maintaining a constructive Technology Base in order to assure the future effectiveness of Army's weapons and materiel. In order to stop the current trend of funding erosion of one-third in real dollars in 10 years, a more aggressive and positive approach was recommended with both OSD and the Congress for 6.1 and 6.2 funding. "Single Program Element Funding" for research and exploratory development was endorsed.

(8) Delegate authority to AMC to either lease or buy laboratory computers depending on need because of the present 40 month lead time for purchase. Approval authority for scientific and laboratory computers needed by the laboratories was recommended to be delegated to AMC up to $200,000 annual lease or $500,000 purchase.

(9) Raise procurement dollar thresholds to catch up to and keep pace with inflation. The funding threshold for R&D contracts requiring Army Secretarial D&F approval should be raised to $250,000 from the current $100,000 level. The current "small purchase" limit of $2,500 should be raised to $10,000.

3.2 Navy Study

The members of the Hazen Study (see Appendix K for membership) examined previous reports relating to the Navy laboratories, and conducted interviews with people in the administrative chain of the Navy's RDT&E efforts from DDR&E to the top and middle management of a variety of laboratories and test facilities. In addition, the Study Team was briefed on the procedures of the other services and visited a number of their laboratories. The objective of these investigations was to determine the nature of the utilization of the Navy laboratories, and to identify factors that might inhibit this utilization.

The group concluded that (reference 19):

(1) the Navy laboratories and test facilities appear to be reasonably matched to the Navy's requirements without unreasonable duplication of facilities and services available elsewhere;

(2) they are performing their functions of assuring technologically up-to-date Naval forces, avoiding the possibility of technological surprise, exploiting new technology, maintaining a technical memory, and aiding in the weapons acquisition process in a relatively effective manner;

(3) the costs of their activities are reasonable and seem comparable to those that would be incurred in industry for similar functions. Only about 1/4 of the total Navy RDT&E budget is spent in-house in the laboratories, the rest either being contracted out directly from headquarters or through the laboratories themselves. It was felt that less than this amount spent for in-house technical work would begin to hamper the laboratories' abilities to perform their missions. No separate examination was made of the Technology Base in-house/contract ratio.

The major in-house laboratories (the nine NAVMAT[6] laboratories and NRL) have much broader mission assignments than the laboratories of the other services, generally spanning the spectrum of RDT&E funding categories and including significant amounts of non-RDT&E funds as well. Their activities are generally Navy mission rather than technology-oriented, and are a mixture of platform, warfare area, functional and technological concerns which equip them well to be of assistance in weapons acquisition from initial concept to in-service engineering.

The team concluded that there seemed to be no fundamental problems in the RDT&E process of such a magnitude as to preclude the Navy's successful pursuit of programs leading to new hardware and software systems. However, the Committee did observe a number of areas where substantive improvements might be made, particularly in a climate of diminishing resources, increasing costs, and the resultant necessity for more options but fewer commitments to engineering development and production.

The current mode of operation in the 6.2 funding area was observed to have a subtask orientation rather than broad program objectives. This fact coupled with the need to obtain funding for the laboratories, was felt to create an atmosphere that provides a permissive license to expand the technical spectrum beyond reasonable mission assignments and to result in duplication and detrimental competition within the in-house laboratories.

It appeared to the group that the greatest potential improvements in laboratory utilization could be made in the management of the RDT&E process. There was felt to be little policy guidance from the upper echelons downward, but a tendency for excessive micromanagement by everyone from DDR&E down through the SYSCOMs, leaving the laboratory management little ability to affect the process "except by indirection."

There was also judged to be little coupling between the 6.1 research programs and the remainder of the Navy RDT&E programs, the in-house laboratories, or the SYSCOMs. Because of difficulty in effecting transition between funding elements, planning has tended to become an element funding process rather than a broad program development effort. There was observed to be a strong tendency to view each Advanced System Concept as a candidate for eventual production instead of regarding 6.3 programs as generating options and

6/Since reduced to eight by consolidation of NWL and NOL into the Naval Surface Weapons Center (NSWC).

alternatives. The decision process by which 6.4 Engineering Development programs are initiated was judged as particularly fuzzy.

In addition to these management problems, the Study found that there were a number of special facilities problems that affected the RDT&E processes adversely. These included the operation, maintenance and updating of T&E ranges, the difficulty of obtaining ship and submarine services for the RDT&E community, the length of time required to obtain military construction funds and the problems associated with obtaining computers for R&D purposes.

The Study proposed that these problems be addressed by combining the planning and management of the 6.1 and the 6.2/6.3A programs under a single command to be entitled the Chief of Naval Research and Technology (CNR&T) who would be in charge of Research and Technology for the Naval Material Command. Programmatic control would be handled by an Office of Research and Technology and implemented through the SYSCOMs and the laboratories. It was recommended that the role of the laboratories in the planning and management (but not necessarily the execution) of the 6.1 program should be increased significantly.

Corresponding to the Office of Research and Technology would be an Office of Laboratory and Range Operations charged with responsibility for policy matters relating to laboratory and T&E facility operations, management, organization, facilities and staffing. This office would also coordinate all Navy RDT&E MILCON requirements and plans as well as control and manage the RDT&E Management and Support (6.5) appropriation.

It was further proposed that along with these changes in the management organization a new Technology Baseprogram planning process be developed that encourages informal discussion, but inhibits low-level person-to-person commitments between the performer and sponsor; heavily involves middle and upper management, especially at the laboratories; results in a package that is negotiated personally by top management within the laboratory and the SYSCOMs; and which is funded and managed as much like a single item as possible without sub-breakdowns against which controls are exercised external to the laboratory.

To improve the effectiveness of this procedure and provide better focus on Navy "needs," program elements should be realigned with the SYSCOMs missions, and a "General Advanced Development Support" element line for each SYSCOM be created to be administered

by ASN(R&D) through the CNR&T, and used to encourage the transition from exploratory development to more advanced phases. These steps would, it was felt, permit better focus of laboratory programs and reduce the existing fragmentation.

It was observed that there currently exist a variety of different methods of developing and training personnel within each of the laboratories and SYSCOMs, ranging from relatively formally structured programs to total laissez-faire. In a period when personnel reductions will undoubtedly be required, it was felt increasingly important that the quality of the people in the laboratories and headquarters be of the highest possible, so the Study recommended the creation of uniform procedures and programs across the entire RDT&E community encouraging the development of technical and managerial talents, giving people the possibility of being exposed to a wide variety of experiences, and clearly linking their achievements to their career pattern and growth.

Because of the importance of maintaining at all times the quality of the work performed in the in-house facilities, the Study urged that the current system of advisory boards be augmented by a quality assessment group including, as required, people drawn from the operating forces, industry and universities to serve as a staff function to the CNR&T.

3.3 Air Force Study

Members of the Air Force study group (see Appendix K) visited all laboratories and facilities specified in their charter. The group examined the "customer/product division" view of the laboratories through visits, discussions and a formal questionnaire solicitation. These fact-finding techniques plus the diversity and depth of background of the study group members provided a comprehensive perspective on the problem.

The Air Force in-house laboratories were viewed by the Air Force system development community in a favorable light although it was felt that the laboratory role was not well understood by many in the Air Force. The former conclusion was derived from a survey questionnaire of seventeen laboratory customer organizations. Generally speaking, the users were very positive in their respective assessments of Air Force in-house laboratories. These laboratories are judged to have competent personnel; to be responsive to requests for support; to be unbiased, objective and motivated by Air Force best interests; and to be at least as good as non-Air Force organizations which provide similar categories of technical support. In the way of

improvements, the responders suggested better communications between laboratories and users. Also recommended were greater visibility control of laboratory projects in the system development area. A flow of personnel from laboratories to project offices was urged, as was the improved transition of technology into new weapon systems.

A projection of Air Force requirements for technical support to future systems development was attempted in the study. The study group concluded that some Air Force laboratories are marginally manned or under-manned for the work they are currently performing toward command, control, and communications systems, the one area where the level of technical support is not sufficiently large.

Civilian leadership in the laboratories was judged to be weaker than desirable. There were felt to be too many senior grade employees who are not well qualified. Civilian grade structure is generally higher in the laboratories than in other Air Force RDT&E organizations, representing a barrier to employee mobility. Civilian personnel turnover in the laboratories is very low, and consequently, average age among civilian scientists and engineers is higher than in other comparable institutions in the United States.

Considerable improvement is possible in inter-Department coordination of RDT&E activities and this is probably best done at the laboratory level. The study group strongly resists centralization of research under OSD to achieve such coordination.

The study group concluded that Air Force laboratories, although small, are of acceptable quality, and very useful in providing a technical capability pertinent to Air Force interests. The Air Force should sustain a strong commitment to its laboratory complex.

It was concluded that the AF 6.1 program could achieve greater results for resources expended and should be better coordinated with other DoD research. A single manager was recommended with a gradual phasing out and redirection of current in-house research laboratories; i.e., phase out ARL and fund CRL out of 6.2.

It was recommended that the AFSC product divisions control the 6.3 and 6.4 funds expended in the laboratories. The intent is to improve relevancy of the projects, bring the laboratories closer to system planning and acquisition, and provide a direct link for the transition of technology.

The study group suggested that some laboratories be affiliated with product divisions: AFATL remain with ADTC; AFAPL, AFFDL, AFAL, and parts of ARL combine into one new laboratory associated with ASD; a part of AFCRL (restructured), RADC and RML affiliate with ESD; and AFRPL with SAMSO. The long range objective is to create a center of technology behind each product division to insure Air Force technical competence in the key product areas of interest. The AFSC product divisions should control the advanced and engineering development funds expended in these laboratories, although the laboratories would continue to report to DS&T. Part of AFCRL, devoted to environmental sciences, would be in this group. The study group recommended no changes in the organizational arrangements under which the MIT Lincoln Laboratory operates, but did recommend a shift of project emphasis toward ESD programs. The laboratories, in the opinion of the study group, are worth the investment of 3% of the Air Force's total funding. It is felt that forcing closer ties with AFSC product divisions should increase the value of this investment.

In the management area, the study recommended greater use of term appointments for senior civilians, a career development plan for RDT&E civilian employees with progression linked to broadening experience outside the laboratories, and a major adjustment of super-grade positions within AFSC.

The use of financial management of manpower rather than manpower ceilings was strongly recommended, but with specific controls over how this authority is used.

It was felt that the use of the laboratories to train military officers in the Research and Development career field should continue.

Finally, the suggestion was made that the current mission of the in-house laboratories should be re-examined, in the light of long-term Air Force system development needs. Although most members of the study group supported the concept of laboratory involvement from basic research to end item feasibility including a specific role in system development and acquisition, the study group recognized that Air Force organizational arrangements and current laboratory capabilities are not compatible with the implementation of such a concept on a broad scale. The study group urges that the in-house laboratory system be recognized for what it is: A collection of small laboratories capable of undertaking or sponsoring good scientific or technical work of interest to the Air Force, and of providing useful in-house consulting and other services to the system developers. It is not a set of "full spectrum" laboratories, nor does it have any major system development capability.

The Air Force has implemented a number of action teams to develop the specifics relative to implementation of the study recommendations.

4. ODDR&E STUDY

Following the completion of the Service studies, the Service outputs were reviewed and critiqued by ODDR&E and additional inquiries carried out in areas where it was deemed necessary or advisable. For the additional work, the professional personnel of the Office of the Deputy Director (Research and Advanced Technology) (R&AT) whose normal responsibility is the management of the Technology Base, were used. There are 17 professionals on the R&AT staff whose backgrounds span the disciplines of DoD RDT&E. Sixteen have advanced degrees and six have Ph. D's. The average experience is 22 years, about evenly divided between industry, in-house laboratory and OSD (see Appendix B for names and additional details). In addition, other DDR&E personnel and the DARPA staff were surveyed to assess their view of the laboratories and the Services' RDT&E management structure.

The principal questions addressed in the ODDR&E study were the same as those the Services were directed to examine: (1) Do we really need in-house laboratories?; (2) If the answer to (1) is yes, are the laboratories organized and operated in a manner consistent with getting the most return on our investment?; (3) Are we properly apportioning the program between the in-house laboratories and the other participants, notably industry and the universities; and (4), Is the size of the laboratory complex appropriate for what it is expected to do?

4.1 Need for the In-House Laboratories

Justification of the existence of the in-house laboratories in a nation dedicated to free enterprise requires demonstration that they do or can provide something that is (a) vital to the system, and (b) not satisfactorily available from other sources such as industry, universities, FCRCs, Headquarters staffs, System Commands, etc.

The in-house laboratories differ from industrial organizations in that (1) they have no profit motive, (2) as part of the Government, they are allowed virtually unlimited information access, and (3), they enjoy a close relationship with their parent Military Service and, consequently, have extensive exposure to and familiarity with Service problems. They also differ from universities in the latter two facets. As a result, the labs should have a better perception of how to bring

technology to bear on the problems of their Service than would industry or the universities and a less biased position than industry.[7] They share the above attributes with Headquarters and System Command staffs, but differ in kind from both of these groups in that the laboratory personnel are actively and intimately engaged in evolving technology and thus represent a degree of familiarity with contemporary technology not usually available from these other "in-house" organizations.

An activity most appropriate for the laboratories as a result of this unique combination of attributes is the vital function of providing technical input to the military planning function, especially to the planning of systems development, acquisition and usage. In addition, of course, the laboratories can and do serve as vital adjuncts to the Services day-to-day technical problems in helping them to be "smart buyers" by providing technical advice and supervision for the Services' interaction with industry. Both of these functions could be provided by Headquarters and System Command staffs, if the staffing policies of these organizations were changed with emphasis placed on current technological competence. Such a change would necessitate staffing these organizations largely with people on rotation from technical organizations (as currently done in ODDR&E, for example). If there were no in-house labs to draw on, these people would have to come from outside the Services. These staffs would then lose much of their depth in knowledge of Service problems and people, reducing their effectiveness as "corporate memories." Only in the in-house labs can we expect to consistently and continually combine both contemporary technical expertise and an in-depth familiarity with Service problems.

The laboratories also represent an alternative source of technology and of at least limited production in some technical areas, so that their very existence serves as a stimulus to industry to perform well for the DoD.

Finally, the in-house laboratories represent technical organizations that can be directed to become centers of technical excellence in areas of little or no industrial interest, such as explosive ordnance disposal technology, nuclear vulnerability and hardening of electronic devices, chemical and biological defense research, military explosives, large caliber guns, etc.

We consequently believe that the current system could not function without the in-house laboratories. It is recognized that there are some program managers in the system that can and do function

7/While the labs lack a profit motive, they do have a strong instinct for self survival, so the degree to which they are truly unbiased really depends upon their assured level of support vis-a-vis their size.

well without any laboratory support. We believe, however, that even these people benefit indirectly from the fact that the laboratories' existence serves as a stimulus to increased industrial performance in many ways. Thus, we conclude quite unequivocally that the in-house laboratories are, in principle, capable of meeting vital DoD needs that are not generally met by other sources. The fact that the laboratories are sometimes not well used or in some specific cases fail to perform, does not affect the validity of the argument for their existence. It does, of course, bear upon the question of their proper size, management and constitution.

4.2 Management of the In-house Laboratory Complex

The ODDR&E personnel have had extensive exposure to the differing structures and methods of management of the three Services' laboratory complexes and related facilities, since many of the staff came from in-house laboratories and all of the staff have daily interactions with them. They also have some familiarity with laboratories outside DoD. This background was applied to the question of how best to operate the DoD laboratories since many are directly involved in intra-governmental technology coordination.

It is evident that no one existing Service laboratory system is clearly the best in all regards, even within the context of its own Service. Rather, it is our belief that a better system can be evolved from an intermingling of the best features of all the systems examined, tailored to the particular environment of DoD and each Service.

Two extreme styles of management for R&D organizations are (1) that in which the laboratories serve as closely directed performers of explicitly formulated tasks, largely under the control of external customers and (2) those in which the laboratories are given broad responsibilities and entrusted to carry out these responsibilities with minimal detailed guidance but with a careful attention to results. Neither of these extremes are, in their entirety, well-matched to the totality of DoD needs. The latter style has generally been most productive in producing innovative new ideas and new technology. The former style recognizes that as a mission oriented agency, there are some specific jobs in RDT&E that need to be done in response to detailed headquarters direction.

We have considered all these factors and derived a set of management principles that state a philosophy of management for DoD PS&E-oriented laboratory/technical centers that we believe to be consistent with DoD needs, reasonably free of internal inconsistencies and

capable of improving the productivity and morale of the laboratories. These are described and defended in Appendix J and summarized in Tables 4-1 and 4-2. They reflect what we believe to be the best features of all systems examined. They have been widely discussed and debated with the DoD RDT&E community and reflect the integrated wisdom of many experienced and thoughtful R&D people. The major feature is that they place the responsibility on the laboratories for the more innovative phases of technology, but make them dependent upon - and responsive to - headquarters directions in support of the development of new systems and the support of existing materiel. They are based upon the observations that most outstanding laboratory systems share three attributes: (1) The assignment to each component of an important job to do; (2) The attraction and retention of good RDT&E leadership; and, (3) The provision of a sufficient flexibility in the system to allow the leadership to most effectively use its talents to accomplish the job assigned.

The details behind the summary statements of Tables 4-1 and 4-2 are in Appendix J and will not be repeated here. However, it seems appropriate to elaborate upon the distinction in how we view the proper laboratory role in the materiel acquisition support function and in the execution of the Technology Base program.

Since Congress has made clear its intention that DoD R&D has no mission to support science or scientific training beyond DoD's own needs, materiel acquisition support (i. e., the support to system planning, development, acquisition, and effective use) must be viewed as the principal raison d'etre of the PS&E laboratories and the ultimate performance measure of importance in assessing the contributions of the laboratories, and indeed of the entire RDT&E establishment, to the DoD.

Recognizing that the primary responsibilities for most materiel acquisition work rests with designated Program Managers, the laboratories should operate their materiel acquisition work on an industrially funded basis in a customer/supplier relationship with the appropriate Program Managers. The degree of their involvement should ultimately be governed by the customers' satisfaction with their contribution to his program. In order to preclude the laboratories being completely subjugated to the Program Managers, however, it is proposed under items 16, 17, and 18 of Table 4-1 to provide some offsetting checks and balances. Perhaps the most important step recommended is that indicated in item 18: To assure that (1) full consideration is given to the use of the laboratories as adjuncts to Program Managers and (2) the laboratories' technical opinions are made available to and evaluated by senior Service management and OSD, we propose to require the appropriate laboratory to formally contribute to the Decision

TABLE 4-1

LAB MANAGEMENT PRINCIPLES

MATERIEL ACQUISITION SUPPORT IS THE END OBJECTIVE OF THE LABORATORIES

1. Labs need a demanding, important mission/product responsibility.
2. Services need multiple sources of technical advice.
3. Lab/Centers should have "full spectrum" involvement.
4. Materiel acquisition and improvement work should be task funded, including overhead, by the customer ("industrially funded").

THE TECH BASE IS A LONG RANGE INVESTMENT IN INCREASING THE SERVICES CAPABILITY IN MATERIEL ACQUISITION

5. Technical area responsibilities should be assigned to each lab appropriate to their mission/product responsibility.
6. 6.1 and 6.2 should be block funded; 6.3 Advanced Technology Demonstrations should be task funded, but from 6.3 funds controlled by the Services' Technology Base managers.
7. Initial Technology Base program planning should be done by Labs.
8. Approval and appraisal chain for the Tech Base program must provide for wide spectrum of advisory inputs, but approval chain must be short, very competently staffed.
9. Responsibility for execution of the agreed program should be assigned to labs; they should be given latitude to achieve endorsed goals; their performance periodically evaluated.

CONTROLS ARE NEEDED ON THE LAB'S SIZE

10. Total Tech Base funding for each lab should be formally controlled as part of budget process.

TABLE 4-1
CONTD

LAB MANAGEMENT PRINCIPLES

11. In-house/contract ratio of block-funded work should be similarly controlled.

12. A total dollar ceiling on each Lab's in-house effort should be set each year by the Services.

13. No additional controls should be placed on the number or distribution of personnel.

14. Improve salary incentives for senior positions is badly needed to assure quality.

15. Lab directors that prove ineffective should be replaced.

CHECKS & BALANCES

16. The Services should assure that labs have access to a multiplicity of customers.

17. Senior people in Service acquisition structure should monitor labs performance.

18. Lab input to the materiel acquisition (DCP/DSARC) process should be requested.

TABLE 4-2

LAB PERSONNEL/PROCUREMENT PRINCIPLES

MILITARY/CIVILIAN INTERFACE

1. Lab staffs should be mixture of military and civilian at all levels.

2. Same qualifications should be required of military and civilians for same job.

MOBILITY IN RDT&E

3. Lab personnel should be encouraged to serve tours in headquarters and on operational staffs.

4. We should provide for continual retraining of lab and Headquarters technical staffs.

MANAGEMENT SUPPORT

5. Personnel policies and regulations should be tailored.

6. Procurement processes should be expedited.

7. Labs should be allowed to have all the support activities they will pay for within their total in-house expenditure ceiling.

Coordinating Paper (DCP) for each new system going to DSARC I and II (see reference 23). Their contribution would be in the form of a Technical Assessment Annex giving their opinion of the technological risk involved in the program and describing the plans for addressing any such risks. More details of this plan are given in Appendix M.

The Technology Base is viewed as a long range investment by the Services and by the laboratories in the Services' future capability to provide more effective materiel and materiel support. A major part of the responsibility for the wise management of this investment should, we believe, be vested in the laboratories, since only they have people of sufficient talent available in large enough numbers to do the demanding task of structuring an integrated, innovative and responsive Technology Base program. The approval and appraisal responsibility for the Technology Base program should be vested in a small, highly competent headquarters staff, and monitored via the present budget approval process by ODDR&E(R&AT).

The laboratories should be controlled by financial controls only, eliminating redundant and often conflicting controls on manpower and financial resources. Control would be exercised by instituting explicit additional financial controls on in-house activities as indicated in items 10, 11, and 12 of Table 4-1 as part of the yearly budget process.

4.2.1 Army Laboratory Management

The impressions that the ODDR&E study received of the Army laboratories can be summarized as follows:

(1) The current system of operating the Army laboratories is the one most nearly in agreement with the management principles of Tables 4-1 and 4-2. They have moved in recent years to adopt what were perceived to be the best features of the Air Force and Navy systems. For example, for the most part, their laboratories have full spectrum involvement, use industrial funding and the customer/supplier relationship in the materiel acquisition phase and a block funded Technology Base. The Technology Base planning process is not as readily discernible as that of the Air Force, however, and it is not clear who is actually doing the planning (it apparently varies between Commodity Commands).

(2) The Army may have the widest span of laboratory quality of all the three Services. Some Army laboratories are regarded as among the better laboratories in the country. On the other hand, several past studies, including AMARC, have been very critical of some of the Army laboratories, a view shared by the ODDR&E and DARPA staffs.

(3) Part of the resolution of the seeming inconsistencies of (1) and (2) above lies in the fact that the Army has been taking aggressive and innovative actions in recent years to upgrade their laboratories. The operating system of item (1) above is quite new in most of the laboratories, based upon a successful trial of several years duration at MERDL. MERDL is regarded as one of the better Army labs, in part as a result of experience under this new approach to lab management.

The AMARC recommendations and the Army's reaction thereto indicate that the Army is aware of its problems and working aggressively to improve the laboratories. We concur in principle with the AMARC-proposed regrouping of the laboratories and the shortening of the reporting chain above the laboratories. The only long term concern regarding the regrouping is that it will diminish competition. However, the Army recognizes this fact and is considering means for overcoming this problem including the AMARC-recommended use of other Government laboratories. The Army's recognition that much can be done to provide increased personnel management flexibility within the existing Civil Service System and its actions to educate its key personnel in how to do so is a commendable practical approach to a difficult problem that we have recommended to the other Services.

Only three shortcomings in the AMARC Study and the Army follow-on actions have been identified by ODDR&E as needing explicit attention. We recommend that the Army develop and document a system for financial control of the sizes of the laboratories/centers and develop and document a formal planning process (perhaps modeled on the Air Force process of reference 21) for the Technology Base and spell out the program approval authority. We also strongly recommend that the Army develop a research and development career pattern for some of its officers with emphasis on advanced technical training and laboratory experience during their early careers to better prepare them for senior technical assignments.

4.2.2 Navy Laboratory Management

The findings and recommendations of the Hazen Report have been taken under consideration by the Navy but no position has yet been taken.

The ODDR&E impressions of the Navy laboratories can be summarized as follows:

(1) They are an integral part of the Navy, deeply involved in the day-to-day programs thereof and depended upon to help keep the fleet operating.

(2) They possess a large reservoir of technical experience including many internationally recognized scientists and engineers. However, the usage of this talent to aid the system planning and development process in the Navy is not all it should be, based upon the laboratories size and technical quality. Both the degree of the laboratories' involvement in system development and their success has varied widely from program to program and among laboratories.

(3) The Navy Technology Base effort is fragmented, composed of an excessive number of usually under-funded programs. With only a few exceptions, it lacks cohesive planning, since the program is the result of "micronegotiation" between working level people in the System Commands and laboratories, with little benefit of the overviews possessed by the top management of any of the organizations involved. Dividing work in closely related technologies among various laboratories also impedes the transfer of technology from the Technology Base to new system developments, since no one technical organization can claim a comprehensive overview of the totality of any technology.

(4) There is, in the ODDR&E view, somewhat more capacity than can be used on meaningful work. This is leading to excess competition between laboratories in order to keep full employment[8] and contributes to the excess of small programs as individual laboratory personnel negotiate small contracts with their system command counterparts to stay funded. A recent study (reference 24) of one Navy laboratory indicated that approximately 20% of the work was of sufficiently low quality or doubtful relevance that it could be stopped without adverse impact on the Navy.

(5) There is perceived by the Hazen Committee and ODDR&E to be a less than optimum distribution of technical expertise in the system. On the average, the best technical competence is in the laboratories while most of the critical technical decisions are made in the System Commands. Significant advantages should accrue from an increase in mobility between laboratory people and the System Commands. The flow of people has been small despite the fact that the grade levels available in the System Commands usually equal or exceed those

8/Figure 2-4 is indicative of the excessive competition with 3, 4, or 5 laboratories involved in almost all end products.

in the laboratories for equivalent positions. One explanation frequently suggested for the reluctance of high quality people to move into the System Commands, despite the grade difference, is that most of the top positions therein are pre-ordained for Naval officers, limiting civilian advancement opportunities. This fact, coupled with the lack of a strong R&D pattern for Naval officers with resulting occasional mismatch between backgrounds and position, seems to be a major inhibitor to mobility. We have no quarrel with the stated need for people with operational experience in the RDT&E system. However, the combination of an improved R&D career pattern to attract and retain officers with good R&D backgrounds to these positions, coupled with "the best man for the job - military or civilian" policy for the appointment of senior personnel, should help increase the System Commands technical competence without undue sacrifice of their operational know how.

Reference to Section 3.2 describing the Hazen Report (reference 19) shows that we are in general agreement as to what the problems of the Navy RDT&E structure are. Consequently, we recommend that the Navy take vigorous steps to correct the following problems of its existing RDT&E system:

(1) Excessive redundancy in functions/platform assignments and concomitant excessive interlaboratory competition for available funds.

(2) Technology Base fragmentation, uneven quality and ineffective technology transfer.

(3) The under-usage of junior officer personnel in the laboratories and the overdependence on Naval officers for positions of senior responsibility.

The Navy should also consider how it will control the size of the laboratories and the Technology Base in-house/contract ratio in a manner consistent with changes made in response to the above recommendations, since current controls would probably be nullified.

4.2.3 Air Force Laboratory Management

The impressions gained of the Air Force laboratories are:

(1) They are reasonably effective at generating an innovative, well-structured Technology Base program and getting it executed, mostly by industry. They are selective in what they undertake and tend to adequately fund programs for the most part.

(2) The heavy military involvement in the laboratories seems to work well. There is a not unreasonable mix between military and civilian personnel in key positions and those military that occupy key positions have had experience "at the bench" early in their military careers and understand how laboratories should function. The R&D career pattern is well developed and has been demonstrated to be an attractive career pattern in terms of promotion potential.

(3) The specialization of the laboratories to the Technology Base makes their contribution to the Air Force less visible to key personnel than would be the case if they were involved more heavily in system development, acquisition and day-to-day problem fixing. This lack of perception of their value could have serious consequences in any future Air Force reductions.

4.2.4 Common Concerns

There are several problems and areas of concern common to all or most Services and therefore are most appropriately addressed by OSD. These are summarized in this section with additional details given in Appendix M.

In section 4.2 it was proposed that the laboratories be included in the DCP/DSARC process by requiring that their comments on the degree of technical risk involved in new program undertakings be formally required. OSD should modify DoD Instruction 5000.2 (reference 23) in the manner indicated in more detail in Appendix M.

All Services recommended and ODDR&E concurs that redundant controls on manpower and funding of the laboratories should be removed. Since all the military departments operate under manpower ceilings, it is desirable to coordinate any experiment in operation without ceilings in the laboratories on a department wide basis. The problem of implementing such controls are discussed in more detail in Appendix M.

Almost all laboratories visited in the course of the study identified personnel practices and regulations and procurement delays as two of the major problems in laboratory operation. OSD should take the lead in attempting to improve these two areas. Some preliminary thoughts on what might be done are given in Appendices E and F.

4.3 Laboratory Size and In-House/Contract Ratio Considerations

The questions of the appropriate size of the laboratory complex and the appropriate in-house/contract ratio are closely related. We will consequently intermingle the discussion of these two points.

The in-house/contract ratio in systems development work is under the control of the appropriate Program/Project Managers. Since most of the system development work is done in industry, the in-house/contract ratio in this area is very small. In fact, the problem in system development is currently one of trying to stimulate the use of the laboratories by the Program/Project Managers rather than preventing excessive in-house involvement.

In the Technology Base, the problem is substantially different. The ratio is substantially larger than in system acquisition. In both the Army and the Air Force the amount of work done in-house has to some extent been left to the discretion of the laboratories. In the Navy, the ratio is presently controlled by the System Commands but would come more directly under the control of the laboratories if the recommendations of the previous section are implemented. For these reasons, the in-house/contract ratio of most concern to this study is that of the Technology Base and it is this ratio to which the study was directed.

Several different approaches were used to assess the appropriateness of the current laboratory division of effort and overall size. The three principal approaches were:

(1) Available data on the size of the Laboratories and their division of effort were collected and analyzed for trends. Most of the data used were taken from two sources. The principal source was the series of documents compiled by the Department of the Army on behalf of OSD, giving personnel and budget data for the laboratories, based upon data submitted by individual RDT&E organizations. [9] Unfortunately, the information in those reports does not separate out Technology Base activities and only separates 6.1 and 6.2 since 1971. In order to estimate the in-house/contract ratios, we used OSD (Comptroller) totals of all contracts categorized as either research or exploratory development to derive the in-house/contract ratio. This omits those 6.3 programs which are properly part of the Technology Base. To minimize the effect of this omission

9/ The data used were mostly that of reference 20; the totals of Tables 1A, 3A, and 5A for Army, Navy and Air Force, respectively.

and the effect of varying interpretations by the laboratories on the data for the aforementioned reports, the analysis concentrated on historical trends, rather than absolute values. The data were aggregated by Service with no attempt to examine the trends of individual laboratories (see Appendix D for detailed in-house/contract data).

(2) We conducted a survey of the opinions of appropriate people in OSD, concentrating on the staffs of ODDR&E and DARPA. These people combine the attributes of (a) familiarity with laboratory programs and capabilities; (b) adequate personal technical expertise and management experience to be capable of judging good R&D; (c) a position of responsibility for the productivity of some part of the R&D effort; and (d) a freedom from responsibility for the maintenance of full employment in the laboratories.

(3) The Navy and Air Force were requested to do assessments of 10-20-30% reductions as part of their study. No assessments were received from the Navy and Air Force so an exercise was carried out by ODDR&E in which gross assessments were made of the potential impacts of various degrees of reduction in the size of the laboratories. The Army had already examined the impact of a large reduction in the AMARC study.

The results of these three efforts and the conclusions drawn therefrom are summarized below.

4.3.1 Trend Analysis

Data upon which our analysis trends are based are summarized in Figures 4-1 through 4-4. The time span shown is bracketed by the earliest and latest Management Analysis Reports (reference 20) available (data for FY 67 were subsequently found but is not significantly different from that of FY 68).

Figure 4-1 compares the trends in the DoD total obligational authority (TOA), the DoD RDT&E budget, the number of civilian personnel in the laboratories and the total in-house program dollar value. Also shown is the growth in Civil Service salaries (ignoring the supergrade ceiling limit which should have a negligible effect due to the small number of people involved).

FIGURE 4–1

TRENDS IN IN-HOUSE LABORATORY SIZE

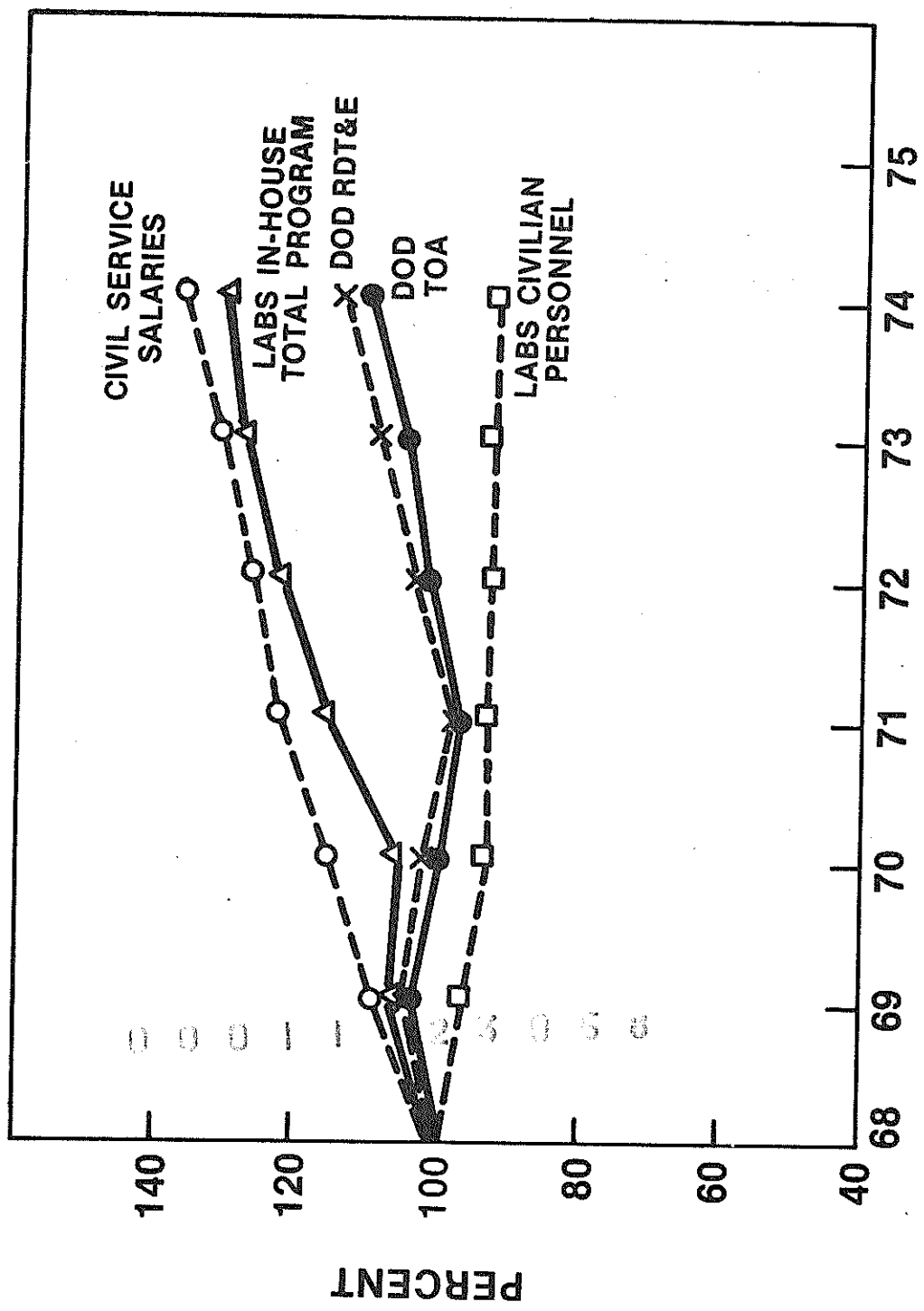


FIGURE 4–2

PERCENTAGE OF RSCH & EXPL. DEVEL. DONE IN DOD IN-HOUSE LABS

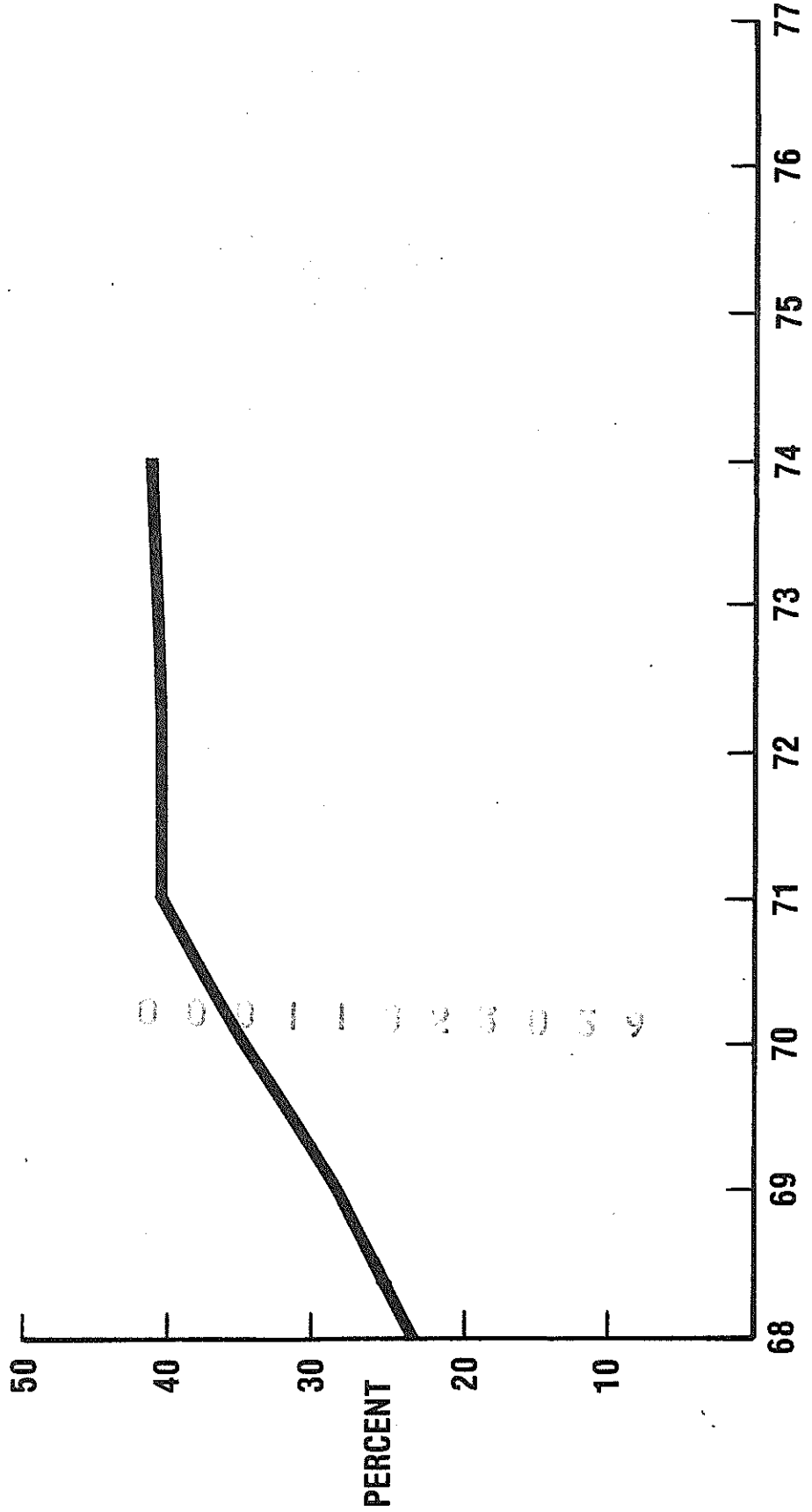


FIGURE 4–3

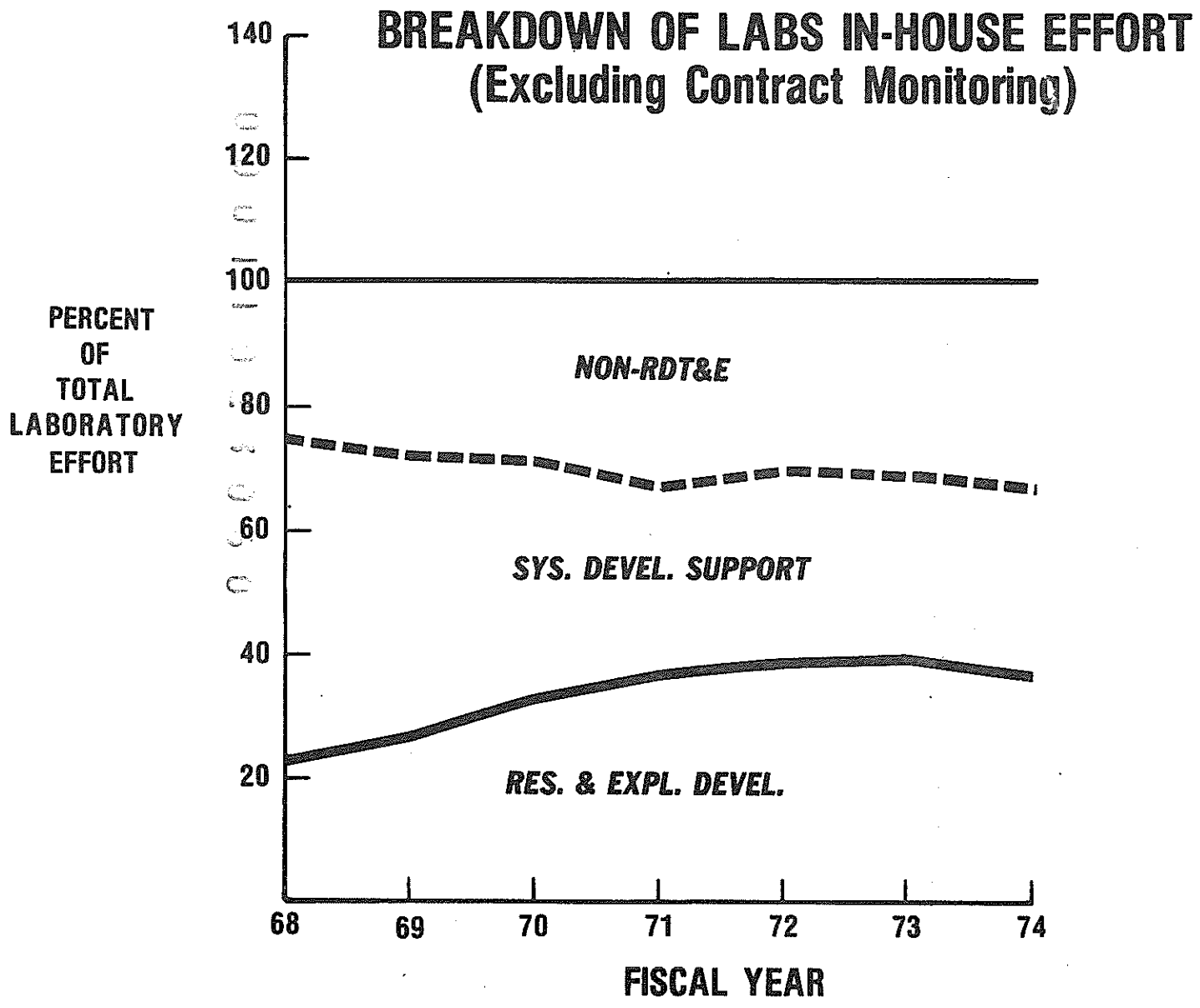
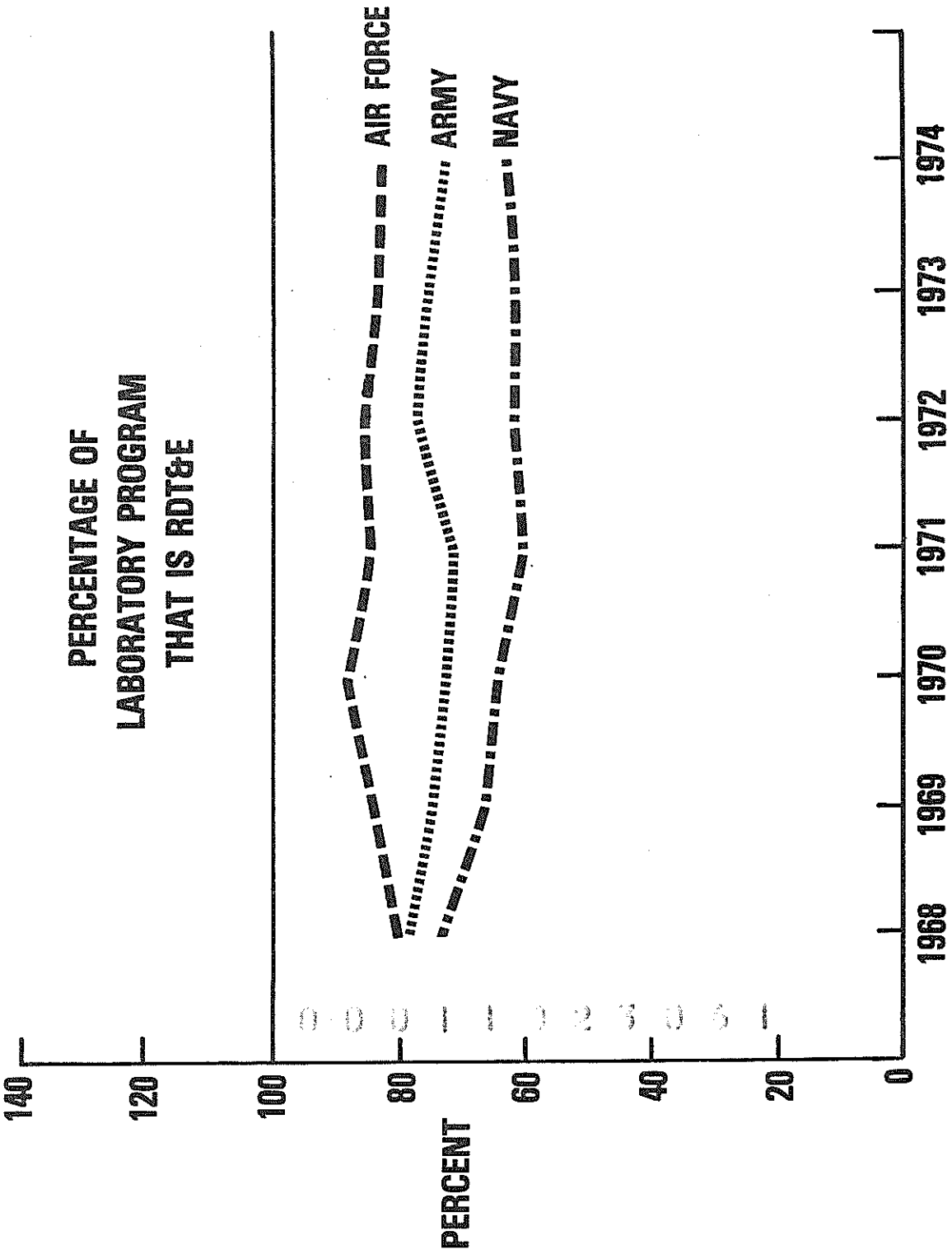

BREAKDOWN OF LABS IN-HOUSE EFFORT
(Excluding Contract Monitoring)
PERCENT OF TOTAL LABORATORY EFFORT
140
120
100
80
60
40
20
NON-RDT&E
SYS. DEVEL. SUPPORT
RES. & EXPL. DEVEL.
68
69
70
71
72
73
74
FISCAL YEAR

FIGURE 4–4


PERCENTAGE OF
LABORATORY PROGRAM
THAT IS RDT&E
AIR FORCE
ARMY
NAVY
PERCENT
140
120
100
80
60
40
20
0
1968
1969
1970
1971
1972
1973
1974
FISCAL YEAR

The figure shows that the contraction in the size of the laboratories has not been sufficient to offset the growth in Civil Service salaries and, consequently, the in-house program had increased in cost by 33% from FY 68 to FY 74, while the DoD RDT&E budget had increased only 15% over the corresponding period and the total DoD budget had increased 12%. Both the in-house program and the DoD RDT&E budget have tracked the Civil Service salary scales fairly well since 1971 so that the in-house program share is no longer increasing.

Figure 4-2 shows the fraction of 6.1 and 6.2 done in the in-house labs, as derived from the Comptroller's figures. The in-house fraction almost doubled between FY 68 and FY 71.

Figure 4-3 explores the breakdown of in-house work in the laboratories. Whereas 6.1 and 6.2 activities accounted for only about 22% of the in-house program in 1968, they now account for almost 40%. Also shown on the figure is the non-RDT&E portion of the in-house program. These activities have increased from about 25% in 1968 to 32% in 1974. Figure 4-4 breaks the latter category down by Service and shows that most of this increase has been in the Navy laboratories. The remaining work we have chosen to characterize as "System Development Support" since it covers 6.3, 6.4 and 6.5 and represents for the most part that portion of the in-house work being done in direct support of the development and acquisition of new systems. This activity, which we consider the raison d'etre for the laboratories, is now down to about half of the level of 1968.

The data of Figure 4-2 indicates the following trends:

(1) A decreased usage of laboratories for support in the Systems Development process.

(2) A tendency to take more of the 6.1 and 6.2 work in-house, and

(3) A growth in support to operational systems and units to offset the decrease in Systems Development work.

Both of the latter categories of work are appropriate for a laboratory but the trends among the three categories are of concern. Some support to operational systems and units and to on-going procurements is vital to maintaining a contemporary knowledge of the problems of one's Service. However, it does not seem appropriate to allow the laboratories to become principally occupied with such support.

Similarly, it is recognized that the laboratories need to do some in-house Technology Base work to maintain competence. In many technical areas, however, most of the significant innovations in the Technology Base have come from contracted R&D. Among the possible reasons for this are:

(1) The number of R&D people expert in most technical areas is greater in industry than in the laboratories so that by selectively contracting with industry we achieve access to a larger variety of ideas than are available from the in-house staffs.

(2) The competitive proposal approach to contracting provides a strong incentive for fresh approaches to problems for those types of problems for which it is appropriate.

(3) In many technologies the state-of-the-art has advanced to the point where unusual fabrication equipment is required for even experimental type work (e.g., integrated circuit fabrication capability for electronic systems, precision manufacturing capability for experimental turbine engines), and these unique facilities and the specialists to operate them are mostly - but not always - found in industry.

One might therefore conclude that almost all of the Technology Base work should be done in industry except for a small level of effort to keep the laboratories current with the state-of-the-art. There are offsetting considerations, however. There are some areas in which the in-house competence matches or exceeds that of industry or the universities. In these areas, one obviously gets the most productive work by keeping the bulk of the effort in-house. Furthermore, there are facilities in some of the in-house laboratories not duplicated elsewhere. Finally, there is diminishing industrial interest in some technical areas that remain of importance to DoD. In these areas, we must, of necessity, bring more work in-house. However, this latter trend has yet to be felt in sufficient strength to justify the large increase in in-house Technology Base activities shown in Figures 4-2 and 4-3.

In summary, based upon the belief that the principal reason we have PS&E laboratories is to support the Systems Development process, it follows that this category of work should be the dominant factor in the laboratories. If the trends of Figure 4-3 accurately reflect the interest in laboratory support on the part of Program Managers, our laboratories are too large and should be reduced by reducing their activities in the Technology Base and non-RDT&E work to restore the balance.

4.3.2 Survey Results

Opinions about the Technology Base in-house productivity vs. contractor productivity, as well as opinions about the proper in-house to contract ratio were solicited from the professionals within the ODDR&E(R&AT) and the DARPA staffs. The DARPA replies are oriented to functional or mission areas whereas R&AT replies are oriented toward Technology Base technology areas. Detailed results appear in Appendix C.

In general, contractors are considered more productive by the DARPA staff but the DARPA replies generally indicated satisfaction with the performance of the in-house laboratories in the Air Force and Navy but dissatisfaction with the Army laboratories.

The ODDR&E(R&AT) staff responses to the survey looked at the technology areas within the Technology Base programs. In the opinion of the R&AT staff, the Technology Base has in general become too much in-house overall, and especially so in some specific areas (see Section 4.3.4).

The estimated ratio of in-house to total activity is shown in Table 4-3, broken down by technology area.[10] Those 6.3 programs regarded as part of the Technology Base are included. The Army and Air Force entries are ODDR&E(R&AT) estimates; the Navy entries have been mutually arrived at by ODDR&E and the Director of Navy Laboratories. The particular areas judged by R&AT to be excessively in-house are underlined; none are judged too little in-house.

4.3.3 Impacts of Potential Drawdowns

In order to assess the impact of potential levels of drawdown, the feasibility of closing laboratories in areas where each of the Services had multiple laboratories with overlapping or closely-related capabilities was considered.

The Army projected that a 20-30% reduction was possible through the consolidation of the Armaments Command laboratories and the formation of the Harry Diamond Development Center. In the case of the Navy, consideration was given to selectively eliminating laboratories in those areas where there were multiple sources of similar end products

10/ The entry "research" covers that part of the 6.1 program not explicitly directed toward one of the other specific areas shown (e.g., it includes the more general disciplines such as mathematics, physics and chemistry research).

TABLE 4-3

TECHNOLOGY BASE % IN-HOUSE BY TECH AREA

	ARMY	NAVY	AIR FORCE
PROPULSION TECHNOLOGY (MISSILE)	50%	40%	30%
MATERIALS & STRUCTURES	80%	55%	20%
AIRCRAFT PROPULSION	30%	15%	20%
AERONAUTICAL VEHICLE TECHNOLOGY	40%	45%	55%
ENVIRONMENTAL SCIENCES	75%	45%	70%
ELECTRONICS	70%	50%	30%
SURFACE VEHICLES	60%	25%	
WEAPONS	70%	60%*	40%
RESEARCH	80%	60%	65%

Note: Underlined areas considered by ODDR&E to be too much in-house.

*High Energy Laser R&D excluded.

(Figure 2-4), based upon qualitative judgments by the R&AT staff that the remaining assets would be sufficient to carry on a minimal program to meet the Navy's needs. In the case of the Air Force, all growth in the laboratories under Project REFLEX was removed, some duplication of technological capability felt by the R&AT staff to exist was eliminated, and one laboratory closed completely on the basis of marginal size, despite the feeling that its work was acceptable and important. The end result was a crude indication that a reduction of up to 20% (approximately 12,000 positions) in the size of the DoD laboratories could be sustained with considerable strain but without a complete overhaul in the Services' system development and procurement methods. The dollar savings would be less than 20%, since some of the work would have to be put out on contract. We could not estimate without a detailed study what fraction would be saved.

We then examined the possibility for consolidation across Service lines by selection of lead Service for systems developments now done in more than one Service (e.g., aircraft, missiles, electronics, etc.). There were three principal results of this portion of the exercise: (1) It was found that the preceeding reduction exercise within each Service had already eliminated much of the similar technical capabilities across Service lines and an additional reduction of only about 1400 people appeared likely beyond the aforementioned 12,000; (2) Service personnel queried felt that the complete loss of readily available technical expertise was intolerable in any area in which they retained responsibility for procurements and thus, if faced with the choice between (a) having fewer laboratories (covering fewer technical areas) but each laboratory of essentially the current size or (b) keeping the current number of laboratories and going to much smaller laboratories, would opt for the latter. (3) The DDR&E staff felt that the elimination of essentially all competition between DoD laboratories would be counter productive in the long run.

The conclusions of this drawdown exercise thus were that (1) without major restructuring of the DoD weapon system acquisition structure, drawdowns in excess of 20% would be inadvisable if not impossible, (2) multi-Service consolidations were not recommended under current procurement practices since the Services did need technical support in areas where they have substantial acquisition responsibility and the DoD needs competition at least between Services.

Explicit study was given to the possibility of a Tri-Service contract research program. We concluded (see Appendix N) that, in the long run, the existence of more than one Contract Research Program is desirable and that the smaller programs of the Army and Air Force should be strengthened to be more comparable to the Navy program.

4.3.4 Conclusions and Recommendations: In-House/ Contract Ratio

The foregoing analysis has established that a reduction in the in-house effort in the Technology Base is warranted. The two questions that need to be addressed are: (1) the overall level of in-house Technology Base effort; and (2) the balance in this effort as indicated in Table 4-3.

The examination of the balance lead to the conclusion that we are excessively in-house oriented in the technical areas of materials and structures, electronics, and weapons in both the Army and Navy laboratories and in the research area in the Army and Air Force. The basis for the judgment differs from area-to-area. The materials work in the Army is too much in-house across-the-board, although we acknowledge that an in-house ratio a bit higher than in most areas is appropriate since AMMRC possesses some facilities not generally available elsewhere. A decrease of at least 20 percent ($2. 5M per year) of the in-house activities in this area in the Army is recommended. In the case of the Navy materials and structures (M&S) work, the level of in-house efforts in support of missiles and aircraft M&S is felt appropriate. However the effort in ships and submarines M&S is almost entirely in-house, which is felt to be too high a level. To encourage more industrial competence in an area in which essentially all production is industrial, we recommend that the in-house effort in M&S for ships and submarines be reduced by a minimum of 20 percent ($2M) resulting in a 10 percent reduction in the in-house portion of the overall Navy materials and structures program. In the electronics area, the existence of a large and vigorous industrial capability argues against the current size of the in-house effort. It is recommended that the Army reduce its in-house effort by at least 20 percent ($12M) and the Navy by at least 10 percent ($7. 6M). In the case of conventional weapons R&D, it is felt that the Army in-house effort has become marginal in productivity and the growth of a larger industrial base should be encouraged by decreasing the Army's in-house activity by at least 20 percent ($17M). The Navy's efforts in conventional weapons, especially in torpedoes and fire control systems is spread among a multiplicity of laboratories, as indicated in Figure 2-4. Some of this diffusion of effort should be eliminated and a minimum reduction of 15% (~ $15M) in the in-house effort is recommended. In research, in order to strengthen the Tri-Service contract programs for the reasons described in Appendix N, it is recommended that the Army decrease its in-house research and increase its Contract Program by $15M per year and the Air Force by $30M. $20M of the Air Force increase

should be achieved by funding Cambridge Research Labs from 6.2 instead of 6.1 as suggested by the Air Force study but without decreasing the level of the total 6.1 program. The additional 6.2 funds required for CRL should be made available by changing the current practice of paying salaries of all development laboratory personnel out of 6.2 regardless of category of work being done.

These funding changes are summarized in Table 4-4 and the approximate Technology Base manpower reductions required indicated in Table 4-5. These were computed at $30K per person, which assumes for computation that all reductions would be a pro rata mix of professionals and support people.

These specific technical area adjustments would leave the 6.1 and 6.2 about 36 percent in-house, averaged across the three Services. Although there are reasons for a somewhat higher in-house/contract ratio now than in the past, based upon the diminishing industrial interest in certain technology areas, we believe a more modest increase from the FY 1968 base would be appropriate. We recommend an in-house ratio of about 30 percent as an objective, to be achieved by additional decreases in in-house activity, but without recommendation of specific technical area to be impacted.

The total Service funding for 6.1 and 6.2 in FY 1975 was $1058.7M so that to reduce the in-house effort from the present 43 percent to 30 percent would require a shift of $137.6M. When converted to positions at an average of $30K per position, this means that the total personnel reduction in in-house Technology Base effort would be about 4,600, necessitating an additional reduction beyond that of Table 4-5 of 1,875. We recommend the distribution of this further reduction as follows:

Army	825
Navy	750
Air Force	300

This apportionment would leave the in-house/contract ratio for the three Services at about 40 percent, 35 percent, and 25 percent vice the current levels of 60 percent, 50 percent, and 30 percent for the Army, Navy and Air Force respectively.

In order to produce the greatest change in in-house/contract ratio with the minimum of personnel disruption, the appropriate

TABLE 4-4

RECOMMENDED SPECIFIC AREA TECHNOLOGY BASE MINIMUM ADJUSTMENTS

(TECH BASE AREAS ASSESSED TO BE TOO MUCH IN-HOUSE)

TECH AREA	ARMY			NAVY			AIR FORCE		
	PRES %	PROP %	DECR. $K	PRES %	PROP %	DECR. $K	PRES %	PROP %	DECR. $K
MATERIALS & STRUCTURES	80	60	2500	55	45	2000	-	-	-
ELECTRONICS	70	50	12000	50	40	7600	-	-	-
WEAPONS	70	50	17000	60	45	14000	-	-	-
RESEARCH	80	57	15000	-	-	-	65	35	30000*
TOTALS			46500			23600			

*Obtained through shifting CRL to 6.2 (20M) without decreasing 6.1 total and ARL closure (10M)

TABLE 4-5

SPECIFIC TECHNICAL AREA TECHNOLOGY BASE MINIMUM REDUCTIONS RECOMMENDED

TECH AREAS	ARMY	NAVY	AF	TOTAL
M&S	80	70		
ELECTRONICS	400	250		
WEAPONS	570	470		
RESEARCH	500	—	385*	
TOTALS	1,550	790	385	2,725

*Closure of ARL, decrease in CRL. Remainder of $30M to come from changes in funding.

amount of the least important in-house Technology Base work should be brought to an orderly conclusion, corresponding personnel reductions made from within Technology Base efforts, and the monies thus released from in-house work used to fund the most promising efforts in corresponding technologies in industry and the universities. No savings in the overall RDT&E is intended from such Technology Base adjustments. The overall level of Technology Base funding is already marginal due to years of constant funding and consequent inflationary loss.

4.3.5 Conclusions and Recommendations: Overall Size

To adjust the division of effort within the laboratories to focus their major effort on support to Systems Development, we recommend decreasing their activities in Research and Exploratory Development per section 4.3.4 and also decreasing their non-RDT&E work so that system development support becomes the largest factor. The level of the in-house program should then be held at approximately a constant fraction of the DoD RDT&E budget for the next several years. In the meantime, a major effort should be made to increase the laboratories' involvement in the Systems Development in an appropriate way; i.e., in the manner which complements rather than competes with industry. Including the laboratories in the DCP/DSARC process in the manner recommended will be a first step in this direction. A re-examination of the laboratory size issue should be made after about 5 years.

Our recommendation is that the overall manning of the PS&E laboratories should be reduced by 10 to 15 percent from the FY 1974 end strength with the bulk of the reduction coming in the in-house support to Research, Exploratory Development, and non-RDT&E activities. This will reduce the portion of the DoD budget going to in-house laboratory work toward the level that existed prior to the current trend away from system development support. This would reapportion the level of effort to place first emphasis on such work. These laboratories had an FY 1974 end strength of 5,418 military and 51,323 civilians distributed as indicated in Appendix L. Consequently, a 10 percent drawdown would reduce the total laboratory complex by about 5500 positions and a 15 percent drawdown will reduce by 8500 positions. The distribution of these reductions among the Services and among the various types of work is addressed below.

The Technology Base reductions of section 4.3.4 account for 4600 positions. It is also recommended that the Navy reduce its non-RDT&E involvement by about 2,000 positions (out of an estimated

Navy non-RDT&E manpower of about 11,000) reducing the Navy's non-RDT&E work from 40% to about 30% of its in-house activities. Monetary savings resulting from this should appear as reductions in required funding in appropriate categories following the reductions.

Table 4-6 indicates the approximate effect of the reduction on the division of effort within the laboratories.

The manpower reductions recommended herein should be accomplished in FY 76 and FY 77. A survey of attrition rates (Appendix G) indicates that it is unlikely that the requisite reductions can be handled by attrition, no matter how the reductions are handled. Since reductions-in-force will therefore be required, it is important that the reductions be designed to minimize the impact in areas that are necessary and functioning well. The reductions should be concentrated in weak areas or weak laboratories, not taken as across-the-board percentage cuts.

It is further recommended in the Laboratory Study that we abandon redundant controls on manpower and funding and use funding controls only. Under such a system, laboratories' in-house allowable funding levels would be controlled as part of the normal budgeting process to allow gradual adjustments to changing circumstances and forestall large reductions in force. Although all the foregoing recommendations are stated in terms of personnel decrements, they can be rapidly reconverted to appropriate changes in in-house funding. Compliance by either figure should be acceptable.

5. SUMMARY OF RECOMMENDED ACTIONS

The Laboratory Utilization Study has addressed three aspects of the DoD in-house laboratory complex, namely, (1) the management and structure of the laboratory complex, (2) the in-house/contract ratio, primarily in the Technology Base, and (3) the proper size of the laboratory complex. The following is a summary of the recommendations from the study.

5.1 Specific Recommendations with Respect to Army Laboratories

We concur in general with the recommendations of the AMARC study which proposed: (1) the restructuring of the Army's many laboratories into a smaller number of development centers and (2) a reorganization of part of the Army Materiel Command to simplify the reporting chain for the commodity command laboratories and (3) several lesser steps as outlined in section 2.3.

TABLE 4-6

APPROXIMATE

REDISTRIBUTION OF IN-HOUSE EFFORT

AS A RESULT OF RECOMMENDED REDUCTIONS

	FY 73 Level ($M)	Pre-Decrement %	Decr. ($M)	Post-Decr. Level	Post Decr. %
6.1 + 6.2	580 (est)	36	150	440	31
Sys. Devel. Supp.	535	33	0	535	38
Non-RDT&E	493	31	60	433	31

ASSUMES:

1) REDUCTION OF 5000 IN TECH BASE ($150M)

2) REDUCTION OF 2000 IN NON-RDT&E ($60M)

3) CONSTANT LEVEL OF SYS. DEVEL. SUPPORT

(BASED UPON FY 73 LEVELS)

There are other issues in the laboratory management area which were not explicitly addressed and for which follow-up actions are recommended. They are:

(1) The Army should formulate and document a system for financial control on the size of the laboratories.

(2) The Army should document the Technology Base program planning and approval authority.

(3) The Army should devise a program for the enhancement of the military R&D career pattern and include therein increased use of technically trained junior officers in the laboratories.

5.2 Specific Recommendations with Respect to Navy Laboratories

As of the writing of this report we had received no indication from the Navy of proposed actions with respect to their laboratories. Based upon ODDR&E observations of the Navy laboratories, we recommend the following actions:

(1) Reduction of the redundancy in functions/platform assignments and concomitant inter-laboratory competition for available funds.

(2) Changes in the Technology Base management and execution to correct the present fragmentation, uneven quality and ineffective technology transfer.

(3) A program for improvement in utilization of Naval personnel in the laboratories, addressing the under-usage of junior officer personnel in the laboratories and the over-dependence on naval officers for positions of senior responsibility.

5.3 Specific Recommendations with Respect to Air Force Laboratories

The Air Force proposed several constructive changes in their laboratories which are endorsed and recommended for implementation. These include:

(1) An increase in the 6.1 contract research program including a change in funding from 6.1 to 6.2 of Cambridge Research Laboratory's environmental sciences work.

(2) Increased laboratory involvement in development through demonstration of end item feasibility.

(3) Amalgamation of the laboratories into centers allied with product divisions.

(4) Product Divisions control of 6.3 and 6.4 funding to the laboratories.

(5) Greater technology focus on Command, Control, and Communications.

(6) Establishment of controls on the laboratory in-house/contract ratio.

(7) Continued emphasis on the use of laboratories for R&D officer training.

Other issues in the laboratory management area in which we believe corrective actions are needed are: (1) the Air Force should discontinue its practice of providing all salary support to laboratory people from main laboratory line program element irrespective of the task to which they are assigned, and (2) a plan for fiscal control of laboratory size in a manner responsive to the Air Force needs and the anticipated RDT&E budget is needed.

6. WHERE DO WE GO FROM HERE?

In the laboratory management area, the principal deficiency remaining in the Study is that of a well-documented plan defining steps to be taken in response to the Study, designating action agents and defining milestones for implementing the recommendations to the Study. The Services should be requested to prepare such a plan. The plan should define the end objectives, the current situation and the plan for achieving the objectives, with milestones. This plan should be a comprehensive description of how each Service intends to operate its laboratories sufficient in detail to become a useful management reference.

The Services should move expeditiously to execute the recommendations of this Study. We believe the long term result will be a significant enhancement of the return on our multi-billion dollar investment in the DoD laboratories. The short term effects are more difficult to predict.

Probably the worst thing that could happen would be to have all recommendations ignored except those to reduce the size of the laboratory complex, and to effect that reduction by an across-the-board cut levied on all laboratories. The result would be a cascading of displacements climaxing in the loss of many of our youngest and best educated scientists and engineers. There is a better way.

We recommend that the reductions be taken by elimination of duplicative or marginally necessary facilities or major portions of laboratories and not as across-the-board cuts. If this is done, it is our conviction that the management changes proposed herein can sufficiently improve the operation of the laboratories to offset the temporary disruption of the recommended drawdowns and we will gain in both the short term and the long term.

Implementation of the recommendations of this study will require a minimum of 2-3 years to fully implement. The process should be watched in the Services and in ODDR&E to insure that the necessary changes are implemented. The effects of the changes should begin to become apparent 3-5 years hence and the situation should be re-examined then. There should be no problem with unintentional changes in the spectrum of work in the laboratories if the controls recommended here are implemented. However, at that time we will have several years of experience at trying to stimulate the interests of Program/Project Managers in the use of the laboratories and the results of that effort should be carefully assessed and the future directions of the laboratories rechartered based upon that assessment.

BIBLIOGRAPHY

1. Performance Measures for Research and Development, Vol. I, May 1973, Committee on Federal Laboratories, Federal Council for Science and Technology

2. Report to the President on Government Contracting for Research and Development, 30 April 1962 (Bell Report)

3. "Review of Management of the Department of the Navy," NAVEXOS page 2426A, 15 December 1962 (Dillion Report).

4. DoD Task 97 Action Group Reports, 1964 and 1965 (Volume III of Phase III only)

5. SECDEF Memorandum of 20 November 1964 to DDR&E with reference (a), "A Plan for the Operation and Management of the Principal DoD In-House Laboratories," of 16 November 1964 (Sherwin Plan)

6. DDR&E Memorandum of 25 November 1964 with "A Proposed Plan for the Organization of the Principal Navy In-House Laboratories," of 16 November 1964

7. "The Environment for Quality," Federal Council for Science and Technology, April 1966

8. "Problems in the In-House Laboratories and Possible Solutions," DDR&E MAM 66-3, 25 Oct 1966 (42 Problems)

9. "Problems in the Management of Department of Defense In-House Laboratories," U. S. Civil Service Commission, 27 December 1967

10. "Profile of Civilian Scientists and Engineers in Field RDT&E Activities of the Department of Defense," DDR&E MAR 69-1, 1 July 1969

11. "Proceedings of Symposium on Education and Federal Laboratory-University Relationships," Federal Council for Science and Technology, 29-31 October 1968

12. "Allocating Work, Funds and Manpower to Department of Defense Laboratories," DDR&E MAR 69-7, 18 December 1969 (Project REFLEX)

13. "Report to the President and the Secretary of Defense on the Department of Defense," Blue Ribbon Defense Panel, 1 July 1970

14. "Report of the Task Group on Defense In-House Laboratories," 1 July 1971, with Annexes A, B, D, E, and F. Annex C summarized significant laboratory accomplishments and is classified Secret (Glass Report)

15. "Relationships between Peer Ratings and Quantitative Properties of Defense In-House Laboratories," DDR&E MAR 71-1, Volumes I and II, 15 November 1971

16. "Report of Defense Science Board Committee on In-House Laboratories," 19 August 1966 (Sheingold Report)

17. 'Report of the Army Materiel Acquisition Review Committee (AMARC)," 1 April 1974

18. "Report of the Special Study Group on The Utilization of the Air Force Laboratories," August 1974

19. "Naval Research Advisory Committee Ad Hoc Subcommittee for the Study of Navy Laboratory Utilization, August 1974

20. Department of Defense In-House RDT&E Activities Management Analysis Reports - Annual 1966 - 1973

21. Handbook for Laboratory Planning, February 1974, Air Force Systems Command

22. A Review of Laboratory Missions and Functions (Navy/Hollingsworth Report), August 1974 AD 0 1 1 3 2 3 0 7 8

23. DoD Instruction 5000.2, "Decision Coordinating Paper (DCP) and the Defense Systems Acquisition Review Council (DSARC)," of 21 January 1975

24. H.R. -9061- Federal Procurement Act of 1974 (Proposed Legislation)

25. GAO Final Report "Project REFLEX (Resource Flexibility) - A Demonstration of Management Through Use of Fiscal Controls Without Personnel Ceilings," 21 June 1974

APPENDIX A

TASKING MEMO &
SECDEF MANAGEMENT OBJECTIVE